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The Genus *Nolina* (Asparagaceae) of the Baja California Peninsula, and the Recognition of a New Species Combination

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Abstract—The genus *Nolina* on the Baja California peninsula has not been critically studied. Most of the taxonomic literature dealing with this group is older or incomplete in nature. Taxonomic problems with this genus arise because it is not easy to make herbarium specimens from plants in the field and the taxa are not well represented in collections. Species in this genus are difficult because they are dioecious, generally have large rosettes with many leaves, leaf margins that often cut skin, and the plants have large inflorescences. On older herbarium specimens, it is common to find only a leaf and an inflorescence fragment, and labels often do not provide taxonomically important information such as the plant’s growth habit type. Consequently, distinctive inflorescence characters are usually missing from the specimen or from the label data. It is rare to find a complete specimen collection that includes all of the needed species-relevant data. Decisions for delimiting species in this genus are not easy, and in this case, were based mostly upon their morphological character consistency, geographic distribution, and environmental factors. Five species of *Nolina* are now registered for the Baja California peninsula: *N. beldingii*, *N. bigelovii*, *N. interrata*, *N. palmeri*, and the new nomenclatural combination *N. brandegeei* (Trelase) L. Hern. This paper includes: a species identification key, species taxonomic descriptions, ecological and geographical information, common names, taxonomic discussions of species, and pictures for species recognition of all taxa in the Baja California region.

Keywords—Mexico, *Nolina brandegeei*, taxonomy.

Resumen—El género *Nolina* en la península de Baja California no ha sido estudiado criticamente. La mayoría de las referencias que consideran al género son viejas o incompletas. Sus problemas taxonómicos se originan por la dificultad de colectar plantas y hacer ejemplares completos, por lo que muestras de estas especies no están bien representadas en los herbarios. Las especies tienen plantas dioicas, inflorescencias, brácteas y rosetas grandes, muchas hojas y márgenes denticulados que cortan la piel. En ejemplares antiguos es común encontrar sólo tienen fragmentos de hojas, así como de inflorescencia y raramente las etiquetas tienen información sobre hábito o características particulares de la planta. Por tanto, no se cuenta con caracteres distintivos de la inflorescencia o datos de estas en las etiquetas de herbario. Es raro encontrar ejemplares completos que incluyan todos los datos específicos relevantes, por lo que las decisiones para delimitar especies en el género no son fáciles y se basan en la consistencia de caracteres morfológicos, distribución geográfica y factores ambientales. Se registran cinco especies: *Nolina beldingii*, *N. bigelovii*, *N. interrata*, *N. palmeri*, incluyendo la propuesta de combinación de un nuevo nombre *N. brandegeei* (Trelase) L. Hern. Se presenta una clave de identificación para las especies, su descripción taxonómica, datos ecológicos, de distribución, nombres comunes, una discusión taxonómica, así como fotografías para reconocerlas.

Palabras clave—México, *Nolina brandegeei*, taxonomía.

The genus *Nolina* Michx. on the peninsula of Baja California, Mexico has not been critically studied. Most of the taxonomic references relating to this genus are old or incomplete (Brandegee 1889; Trelase 1911; Wiggins 1980). For example, the Flora of Baja California by Wiggins (1980) included four species of *Nolina* with three varieties. He considered *N. parryi* S. Watson as present in Baja California, but no herbarium specimens or any other legitimate record has been found to scientifically substantiate this report. He also recognized *N. beldingii* Brandegee var. *deserticola* Trelase, which is considered here as a synonym for *N. bigelovii* (Torrey) S. Watson, but he did not mention *N. beldingii* which occurs in the Cape Region. A detailed revision of the specimens and their localities is required to know and understand the species of *Nolina* on the peninsula of Baja California. Recently, Rebman and Roberts (2012) published a new edition of a field guide for the Baja California plants, reporting just three species and two varieties of one species (*Nolina beldingii*; *N. bigelovii*; *N. palmeri* S. Watson var. *palmeri*; and *N. palmeri* var. *brandegeei* Trelase). Problems with the taxonomy of *Nolina* arise from the fact that it is not easy to make taxonomically complete herbarium specimens from field plants, and consequently, the plants are not well represented in herbarium collections. Most species in this genus have large rosettes with many leaves, large inflorescences, and are dioecious with separate staminate and pistillate individuals. On older herbarium specimens, it is common to find only a leaf and an inflorescence fragment and the labels do not typically have information such as the exact locality or the plant growth habit. Furthermore, since most *Nolina* rosettes are big, coarse, and have denticulate leaf margins that can hurt or cut skin when working with them, many botanists just collect young and immature leaves. As a result, the leaves on herbarium vouchers have been incorrectly considered mature ones yielding different color ranges and leaf sizes. Finally, since *Nolina* inflorescences are so large, most of the time the few reproductive structures that are present in plant collections are inflorescence branches or only small parts of the branch segments. Taxonomically important characters such as inflorescence size, shape, scape size and diameter, inflorescence bracts, number of branches, branch bracts, branchlets, branchlet bracts, and in several cases the apical branchlet or end of a branch, are usually missing from specimens and are not recorded in the label data. When studying vouchers of the same species from many different herbaria, it is rare and fortunate to find specimens that include mature leaves, inflorescence and floral bracts, stamine flowers, pistillate flowers, and mature fruits. As a result, decisions for species delimitations are not easy in this group.

For this study, most of the information was obtained from literature (Brandegee 1889; Trelase 1911; Moran 1952; Gentry 1972; Wiggins 1980; Hochstätter 2010; Rebman and Roberts 2012), specimen studies in herbaria (ASU, BM, BCMEX, CAS/DS, GH, HCB, K, MEXU, MO, SD, and TEX), data from the bajasflora.org website (including the Baja California Botanical Consortium specimen records from six different herbaria in both the USA and Mexico), and fieldwork. The species
circumscriptions in this study were based upon the consistency of their morphological characters, geographic distribution, and environmental factors. It is interesting to note that most species in the Baja California region occur in high elevation areas of the sierras in both states on the peninsula. However, even though the populations are separated on mountain sky islands, it is possible to envision a coherent distribution of each species based upon geological substrates (Martín Barajas 2000). As a result, five species are considered to occur on the peninsula of Baja California with no infra-specific categories recognized. In addition to the four previously recognized species, Nolina belingii, N. bigelovii, N. interrata, and N. palmeri, a new nomenclatural combination is proposed for an additional species, Nolina brandegeei (Trelease) L. Hern.

**Nolina Michx**

Plants dioecious, arborescent or acaulescent plants with leaf rosettes at the apices of stems and branches. Leaves linear, flat or concave, green or glaucous green, with leaf margins microdenticulate or fibrous. Inflorescences a panicle with a scape and branches subtended by deltoid or triangular to linear bracts. Second order branches or branchlets subtended by triangular to linear papery bracts. Flowers campanulate, in fascicles or secondarily solitary, surrounded by lanicinate or dentate membranaceous bracteoles; tepals 6 in two series, whitish, the midvein apparent, trichomes at the apex; staminate flowers with 6 stamens, anthers introrse, sagittate, ovary not developed and functioning as a nectary, tepals reflexed at maturity; pistillate flowers with 3-carpellar ovary, rounded; stigmas sessile, 3-branched or 3-lobed; staminodes 6, septal nectaries present; ovules basal, 2 per carpel, sometimes subtended by a shelf-like or a small protruding structure. Fruits 3-lobed, dry, indehiscent, with an apical notch that bears the persistent stigmas; tepals persistent, all reflexed or at least the external ones. Seeds round, 1–2(–3) mm per fruit, in any case, one per locale or none if ovules abortive, exposed at maturity or not; tests smooth, microreticulate or reticulate, brown or gray.

### Key to the Species of Nolina on the Baja California Peninsula

1. Plants acaulescent, stems subterranean, horizontal or vertical, then short and almost aerial ........................................................................... 2.
2. Stems horizontal, subterranean, leaves glaucescent, flat, coiled, apex erect, inflorescence branches loose and lax, seeds not protruding from the fruit lobe ...................................................................................... Nolina internata.
3. Stems vertical, leaves green, concave in cross section, erect, apex coiled, inflorescence branches dense and stiff, seeds protruding from the fruit lobe Nolina palmeri.
4. Plants acaulescent, leaves denticulate, seeds microreticulate, brown ....... Nolina belingii.
5. Plants shrubby, leaves fibrose, seeds reticulate, grayish to light brown Nolina bigelovii.
6. Leaf narrowing or with a constriction above the base, apex entire, leaf margins with simple teeth, fruits 0.9 cm long, 1.4–1.5 cm wide, seeds not exposed at maturity Nolina brandegeei comb. nov.
7. Leaf not narrowing or without constriction above the base, apex shedded, leaf margins with branched, forked or multiple teeth, fruits 0.6 cm long, 1 cm wide, seeds exposed at maturity Nolina interrata.

**Nolina belingii** Brandegee, Zool. 1: 305. 1890. Type: Mexico: Baja California Sur, La Chuparrosa, 17 Oct. 1893, T. S. Brandegee s. n. (lectotype UC! (accession number: 142652); isooletotypes: BM!, GHI!, KEW!, and the fragment at MO labeled as October 18, 1893).

Plants arborescent, 3 to 7 m high, trunk 50 cm diam, bark fissured forming rectangular blocks 10 to 25 cm long with ridges 5 cm deep, gray to maroon with age; branches with 1 to 26 apical leaf rosettes, 2 to 3 m diam, leaving persistent old leaves on at least half the size of the branches and trunk or even more. Leaves long linear, 0.75–1.15 mm long, 1.4–2.0 cm wide at the middle, sometimes narrower or with a constriction above the base, flat in cross section, smooth, dark green, sometimes reddish at the back; base long triangular, (4.5–7) to 9 cm long, (3.5–4) to 5 cm wide at the inferior part, 1.4 cm wide at the superior part; leaf apex entire; leaf margin denticulate, with very small teeth or denticles ca. 0.2 mm long, yellowish. Inflorescences paniculate, largely ovoid, 2 to (3–5) m long, 20 to 70 cm diam, rachis undulate; scape 1 m, smooth, bracts linear, decreasing in size towards the apex from 60 to 40 cm; branches lax, curved to undulate, perpendicular to slightly ascending, 23 cm long, decreasing in size towards the apex to 15 cm, with two weak basal branchlets (ca. 1/5 the size of the branches), subtended by largely triangular papery bracts, 18 cm long, decreasing in size towards the apex to 3 cm, bract base blotched with red or purple; branchlets lax, 8 cm long, decreasing in size towards the apex to 2 cm long. Staminate flowers 2(–3) per node, campanulate, 4 to 6 mm diam on pedicels 2.5 to 3 mm long, articulated at or above the middle, surrounded by membranaceous bracteoles 2 to 3 mm long with lanicinate margins; tepals ovate to lanceolate, 3–4 mm long, 1.5–2 mm wide, the external ones with apiculate apices, all reflexed from the middle part at maturity; filaments 2–2.5 mm long; anthers 1–1.5 mm long. Pistillate flowers 2 per node, campanulate, on pedicels 4 to 8 mm long articulatet near the base, surrounded by two membranaceous bracteoles 2 to 4 mm long, margins lanicinate; tepals lanceolate, 3 to 3.5 mm long, 1.5 mm wide, light yellow to cream with the midvein reddish to purple; ovary 3-lobed, 2–4 mm diam; style 0.2–0.4 mm long; stigmas 3-lobed. Fruits 1(–2) per node, depressed, 0.9 cm long, 1.4 to 1.5 cm wide, with persistent tepals, reflexed at maturity; peduncles 9 to 11.5 mm, articulated near the base. Seed 1 per fruit, 4.5 mm long, 3 mm wide, ovoid, not exposed, and green to brown, grayish at maturity, hilum yellow. Figure 1.

**Ecology and Distribution**—This species occurs on steep slopes and cliffs at the highest areas in the Sierra de La Laguna, in the state of Baja California Sur, Mexico, in oak forests (Quercus species) with Quercus turbinata Liebm., Q. devia Goldman, Q. arizonica Sarg., Arbutus peninsularis Rose & Goldman, Sideroxylon peninsulare (Brandegee) T. D. Pennington, Buddleja crotonoides A. Gray, Randia capitata DC., Muhlenbergia spp., Opuntia spp., Croton sp., from 1000 to 1800 m in elevation, on granite outcrops (Fig. 2). This species flowers from May to June and fruits from June to August.
that some vouchers were not deposited into others or at least at UC where the largest portion of Brandegee’s herbarium collection is currently housed. He dedicated the specific epithet to Mr. L. Belding, but apparently did not see his specimen collection (Belding 6 at GH, which represents a small individual), and just said that he “was the first to notice it in his ornithological expeditions to the Sierra la Laguna, several years ago, and gave me directions as to the route by which I was enable to find it.” The best specimen collection for *N. beldingii* is at UC is from La Chuparrosa (“Chuparosa” spelling variant), dated 17 October 1893, with duplicates at GH, BM, KEW, and MO. However, the voucher at MO is a mixed sheet with *N. brandegeei* from San Julio, 19–20 April 1889). There are also older specimens from the Sierra de San Francisquito,
labeled as Brandegee 583 but with different dates, the one at GH is from March 29, 1890 and the one at UC is from March 29, 1892. In the paper on Brandegee’s itineraries, Moran (1952) considers the last date (1892) as the correct one, and it is the one accepted here. A voucher with a collection date after the original publication date cannot be considered an inferred type specimen, but since Brandegee did not mention any specimen in his original publication, and since Belding’s specimen and the collection from the Sierra de San Francisco are not complete, and also labeled with different dates, it seems best to assign the specimen from La Chuparrosa at UC as the lectotype, and the vouchers at BM, GH, K EW, and the fragment at MO labeled as October 17, 1893 as isolectotypes.

FIG. 2. Distribution of Nolina interrata and N. beldingii on the Baja California Peninsula.
Nolina beldingii is an endemic species to the southern part of the Baja California peninsula which occurs only in the Sierra de la Laguna. Taxonomically, this species is close to N. brandegeei. They can be readily distinguished because N. beldingii has longer leaves (ca. 1 m) usually narrow or with a constriction above the base, entire leaf apexes, and larger fruits and pedicels. Nolina beldingii is locally known as “sotol” or “palmilla” and its leaves have been used for thatching (Fig. 1).

Representative Specimens Examined—Mexico. BAJA CALIFORNIA SUR: La Laguna, I. L. Bel dign 6, 3 Feb s/s (GH); Sierra de San Francisco, 29 Mar. 1892, T. S. Brandegeee 583 (GH as 29 Mar. 1890, UC); La Chuparosa, 17 Oct. 1893, T. S. Brandegeee s/n (GH); La Laguna, Sierra de la Laguna, 21 Jan. 1906, E. Nelson & E. Goldman 7465 (US); La Laguna, Sierra La Laguna, 24 Mar. 1939, H. S. Gentry 4424 (CAS, GH, KEW, MO); Valle de la Laguna, 23 Aug. 1944, M. Martinez s/n (MEU); Along trail to La Laguna, Sierra de la Laguna, E of Todos Santos, 28 Dec. 1947, A. Carter 2443 (US); Rancho Laguna and vicinity, Sierra Laguna, Cape District, 3 Oct. 1951, H. S. Gentry 11216 (MEU); From San Jose to San Francisco and La Chuparosa, East of Sierra de la Victoria, 12 Apr. 1955, A. Carter 3331 (GH, MEXU, MO, SD); Cape Region, Potrero de Almelta near head of S fork canyon San Pedro, 9 May 1959, R. Moran 7369, 7369A (GH, MEXU, SD); Cape Region about La Laguna, 16 May 1959, R. Moran 7428 & 7428A (GH, MEXU, SD); La Laguna, Sierra de la Laguna, Huerigo Canyon, 24 Aug, 1959, C. H. Love 3064 & R. L. Turner 59-159 (MEXU, MO); At end trail La Burrera - La Laguna, Cape District, 21 Aug, 1972, A. J. Gilmantran 1840 (MEU); Sierra de la Laguna, trail to La Laguna, ridge above tributary of Cañon la Burrera, just west of la Laguna, about 30 km (air) northeast of Todos Santos, 19 Mar. 1998, M. Fishbein 3167 (MEXU, MO); arriba de la cabaña de Cano, 17 Apr. 2008, H. S. Gentry 978 (MEXU, SD); Cuenta y Cienaga, 26 Oct. 2009, M. Fishbein 3169 (MO, SD); La Laguna, 21 Oct. 2010, M. Fishbein 3173 (MEXU, SD); Sierra de la Laguna, La Chuparosa, 17 Oct. 2010, M. Fishbein 3177 (MEXU, SD).

Ecology and Distribution—Plants of Nolina bigelovii grow on steep slopes in forests and chaparrals at 540 to 1250 m elevation on granite outcrops of the sierras of the state of Baja California, such as at La Rumorosa in the Sierra de Juárez, Sierra de San Pedro Mártir, Cataviña, Sierra de San Borja, and Isla Angel de la Guarda (Fig. 4). This species is also found in Sonora, Mexico, and in California and Arizona in the USA. It is locally known as “palma.” Flowers are present May to June and fruits from June to November.

Representative Specimens Examined—Mexico. BAJA CALIFORNIA: Cañón Cantillas, Jun., 1 Jul. 1884, C. Orcutt s/n (MEU); Tule Mountains, Mexican boundary line, 11 Feb. 1894, E. A. Manns 279 (MO, US); Jarayaga, about 50 km SE of San Fernando, 9 Sept. 1905, E. W. Nelson & A. Goldman, 7130 (US); J. Yarayaga, 16 Jul. 1941, Harbison C. 310 (SD); East end of Sierra San Luis; 26-30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD); Cantiñas (Tantillas) Canyon, 8 Sept. 1952, C. Harbison s/n (SD); Summit of Cerro Quemazoá, Sierra San Borja, 26 Mar. 1960, R. Moran 8074 (CAS, SD); Canyon above El Terminal, Sierra San Borja, 7 June 1962, R. Moran 9732 (CAS, SD, US); Arroyo de la mina de Santa Marta, 9 June 1962, R. Moran 9763 (SD); San Borja grade, about 4 mi E of La Rumorosa, near Terrizacalli road, 30 June 1962, R. Moran 9781 (MEXU); La Suerte, San Pedro Martir, 4 June 1963, R. Moran 11163 (BCMEM, CAS, SD); of the Deserticola s/n (SD); East end of Sierra San Luis; 26-30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD); Cantiñas (Tantillas) Canyon, 8 Sept. 1952, C. Harbison s/n (SD); Summit of Cerro Quemazoá, Sierra San Borja, 26 Mar. 1960, R. Moran 8074 (CAS, SD); Canyon above El Terminal, Sierra San Borja, 7 June 1962, R. Moran 9732 (CAS, SD, US); Arroyo de la mina de Santa Marta, 9 June 1962, R. Moran 9763 (SD); San Borja grade, about 4 mi E of La Rumorosa, near Terrizacalli road, 30 June 1962, R. Moran 9781 (MEXU); Yubay, 10 Oct. 1962, C. Harbison s/n (SD); NW of Cerro San Luis, 2 Mar. 1963, R. Moran 10278 (CAS, SD); Peak ca. 4 miles SE of Refugio Bay, Isla Angel de la Guarda, 22 Mar. 1963, R. Moran 10479 (CAS, SD, US); Rancho La Suerte, San Pedro Martir, 4 June 1963, R. Moran 11163 (BCMEM, CAS, SD); NE of Yubay, 30 Apr. 1964, C. Harbison s/d (SD); just above trail down into Cantiñas Canyon. El Progreso, Sierra Juarez, 13 May 1971, O. Ramírez 11 (BCMEX, SD, MEXU); La Laguna, 21 Oct. 2010, M. Fishbein 3169 (MEXU, SD); Cantiñas Canyon, 1 Nov. 1965, J. L. de la Luz 7073 (MEXU, SD); Cantiñas canyon, 26 Oct. 2009, M. Fishbein 3169 (MEXU, SD); Cantiñas canyon, 30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD); Cañón del Diablo, Sierra de San Luis, 26-30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD); Cañón del Diablo, Sierra de San Luis, 26-30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD); Cañón del Diablo, Sierra de San Luis, 26-30 mi north of Punta Prieta, 3 Apr. 1950, H. S. Gentry 9871 (MEXU, SD).
considered by Hochstätter (2010) and Thiede (2012) within the section Microcarpa with acaulescent plants, and narrow leaves with coiled tips, but our study found enough morphological differences to elevate in taxonomic rank to the species level.

*Nolina brandegeei* is quite different from *N. palmeri* because it is an arborescent plant with linear leaves that have no narrowing or constriction above the base, leaf margins with erect and forked denticles, leaf tips shredded, fruits 0.6 cm long, 0.9 to 1 cm wide, fruit peduncles 6–12 mm long and articulated near the base, and flowers present in summer with fruits mature in fall, seeds exposed at maturity. This taxon resembles *N. beldingii*, but that species has leaves with a constriction above the base, leaf margin with curved and nonforking denticles (Fig. 5), leaf apices entire, fruits 1 cm in...
diameter or more, flowers produced in spring with fruits maturing in summer and seeds not exposed in mature fruits.

Arborescent plant, 2 to 6 m high, trunks 20–30 cm diam, usually branched with apical rosettes, old specimens much branched; branches separate from each other at 30° to 40°; bark gray, fissured, forming small rectangles. Rosettes massive ca. 1.5 m in diam, with erect leaves, reflexed at maturity, persistent and covering the branches, but not the trunk. Leaves linear, not narrowing or constricted above the base, 95 to 120 cm long, 1.0–1.5 cm wide at the middle, flat in cross section, green to glaucous green; leaf bases triangular, 4.5–7 cm long, 5.0 at the base, and 1.3–1.7 at the top; margins denticulate; teeth 0.2 mm, erect to curved, forked or branched, sometimes fused. Inflorescence 1 to 3.5 m long, 30 cm wide, ovoid; scape 15 to 70 cm long, 1.5–2.0 cm diam; bracts linear to long triangular, 47 cm long decreasing apically in size to 20 cm;
inflorescence branches perpendicular to ascending, up curved below the middle, 43 cm long, decreasing apically in size to 10 cm, subtended by bracts 17 to 6 cm long; branchlets 14 to 3 cm long, the final branchlets 5 to 8 cm long. Stamine flowers campanulate, 2.5 mm diam, 2 to 3 per node on pedicels 2 to 3.5 mm articulated below the middle, surrounded by wide lanceolate membranaceous bracteoles, 1.5 to 3 mm long, persistent, whitish to yellowish, margins laciniate; tepals oblong to oblong-lanceolate, 2.5 mm long, 1 mm wide, reflexed at maturity, apex with a glandular pilose area 0.1 mm long; filaments 1.5 mm long, anthers 1 to 1.2 mm long. Pistillate flowers campanulate, 2.5 mm diam, 1 to 2 per node, on pedicels 3 to 3.5 mm long, articulate below the middle, surrounded by lanceolate membranaceous bracteoles 1.5 to 3 mm long, persistent, yellowish, margins laciniate; tepals lanceolate, 2 mm long, 1.5 mm wide, thickened at the middle of the base, style very short, stigmas 3-branched; nectaries septal, at the base of the ovary. Fruits depressed, 1(–2) per node, 6 mm long, 10 mm wide, on peduncles 6 to 12 mm long, articulate near the base, tepals persistent, the internal appressed covering the nectaries, the external reflex. Seed 1(2 or 3) per fruit, ovoid to ellipsoid, ca. 3.5 mm long, 2.5 to 3 mm wide, exposed at maturity, maroon. Figure 6; Table 1.

Ecology and Distribution—This species occurs on north-facing slopes, on steep hills and in canyons with alkaline igneous rocks in the sierras de La Giganta, San Francisco, Guadalupe, Las Palmas, and San Bruno in the state of Baja California Sur (Fig. 7). The plants grow mostly in Quercus forests and desert scrub with Brahea brandegeei (Purpus) H. E. Moore, Fouquieria columnaris (Kellogg) Curran, Ebenopsis confinis (Standl.) Barneby & J. W. Grimes, Prosopis sp., and Croton sp., from 700 to 1900 m altitude on volcanic rocks. The plants flower from June to September, and set fruits from October to December.

To assess the identity of the proposed taxon, a set of problems was found within the herbarium collections concerning the probability that this taxon could be either part of N. palmeri or of N. bigelovii. According to Brandegee (1889), he collected one specimen of an unknown Nolina at San Julio on April 19–20 of the same year. He stated that the plant has “leaves only of an arborescent branching species, 15 feet high with light green narrow leaves 3–4 feet long.” These details, and the fact that he also cited a young specimen of N. bigelovii from Ubi (Yubay), show evidence that he knew the species, and that it was a different taxonomical entity (Table 1). Recently, Hochstätter (2010)

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presented an article on *Nolina*, considering *N. palmeri* var. *brandegeei* as a synonym for *N. palmeri*. But, the paper appears to be mainly a bibliographic revision and not a detailed taxonomic treatment. However, though *N. brandegeei* has similarities with *N. palmeri*, including the exposed seeds at maturity, it differs greatly in its arborescent habit, larger and flat leaves, leaf margin denticles forked, shredded and not coiled leaf tips, and larger fruits (Fig. 4). In addition, the type specimen of *Nolina brandegeei* (Trelease) L. Hern. comb nov. deposited at MO should be relabeled as collected at San Julio, Baja California Sur, on April 19–20, 1889.

Table 1. Differences between Nolina beldingii, N. brandegeei comb nov., and N. palmeri (Figs. 1, 5, 6).

<table>
<thead>
<tr>
<th>Characters</th>
<th>Nolina beldingii</th>
<th>N. brandegeei</th>
<th>N. palmeri</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>Arborescent</td>
<td>Arborescent</td>
<td>Aculeaens</td>
</tr>
<tr>
<td>Bark plates</td>
<td>Deep elongated rectangles</td>
<td>Rectangular</td>
<td>Pyramidal polygons</td>
</tr>
<tr>
<td>Leaf</td>
<td>Flat</td>
<td>Flat</td>
<td>Concave</td>
</tr>
<tr>
<td>Leaf base</td>
<td>With constriction</td>
<td>Without constriction</td>
<td>Without constriction</td>
</tr>
<tr>
<td>Leaf margin denticles</td>
<td>Curved</td>
<td>Erect</td>
<td>Curved</td>
</tr>
<tr>
<td>Denticle</td>
<td>Entire</td>
<td>Forked</td>
<td>Entire, rarely forked</td>
</tr>
<tr>
<td>Leaf apex</td>
<td>Entire</td>
<td>Shredded</td>
<td>Slightly shredded</td>
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<tr>
<td>Staminate flowers per node</td>
<td>2(3)</td>
<td>2-3</td>
<td>1(2)</td>
</tr>
<tr>
<td>Stamen filaments size</td>
<td>2-2.5</td>
<td>1.5</td>
<td>1-1.2 mm</td>
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<tr>
<td>Fruit size</td>
<td>1 × 1.6 cm</td>
<td>0.6 × 1 cm</td>
<td>0.4 × 0.6 cm</td>
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<tr>
<td>Fruit peduncle size</td>
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<td>6-12 mm</td>
<td>3-4 mm</td>
</tr>
<tr>
<td>Fruit peduncle articulation</td>
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<td>Near the base</td>
<td>Near the base</td>
</tr>
<tr>
<td>Seed</td>
<td>Not exposed at maturity</td>
<td>Exposed at maturity</td>
<td>Exposed at maturity</td>
</tr>
<tr>
<td>Seed size</td>
<td>4.5 × 3 mm</td>
<td>3.5 × 2.5-3 mm</td>
<td>3.5-4 × 3.5-4 mm</td>
</tr>
<tr>
<td>Flowering time</td>
<td>Spring</td>
<td>Summer</td>
<td>Spring</td>
</tr>
<tr>
<td>Fruiting time</td>
<td>Summer</td>
<td>Summer and fall</td>
<td>Summer and fall</td>
</tr>
</tbody>
</table>

Representative Specimens Examined—Mexico.—BAJA CALIFORNIA SUR: San Julio, 11 Apr. 1889, Brandegee s/n (UC); Ubi, Agua Bonita, 8 May. 1889, Brandegee s/n (UC); Sierra La Giganta, above Los Encinos, 1 Mar. 1939, H. S. Gentry 4292 (GH, MO); Ridge northwest of main peak, Cerro de La Giganta, 23 Nov. 1947, A. Carter 2038 (L, MEXU, US); North slope of Cerro San Juan, 4 Feb. 1964, R. Moran 11584 (SD); Summit of Volcán las Tres Virgenes, 12 Feb. 1964, R. Moran 11697 (SD, US); North slope, summit of Cerro de la Higuera, Sierra San Francisco, 21 Feb. 1964, R. Moran 11713 (SD); Summit, Cerro Natividad, Sierra San Francisco, 24 Feb. 1964, R. Moran 11751 (SD); At pass ca. 3 miles west of ex-mission Guadalupe on trail to San Pedro, 11 Mar. 1964, R. Moran 11790 (CAS, SD); North slope at summit of Cerro Azufre, 20 Oct. 1971, R. Moran 18736 (SD, US); North slope of Cerro Barranco, Sierra de Guadalupe, 23 Oct. 1971, R. Moran 18822 (SD); Sierra de La Giganta, Cerro Mechudo, the southernmost peak of the Sierra, 2 Nov. 1971, R. Moran 18882 (BM, MEXU, SD); N slopes of NE side of Volcán Tres Virgenes, 12 Apr. 1973, J. Hinckinson 8893 (SD); Sierra de Las Palmas, W de San Bruno (31 miles), 20 Jun. 1973, H. S. Gentry 23319 (AZ, DES, CAS, MEXU, US); Rancho La Laguna, Sierra San Francisco, 23 Nov. 1976, R. Moran 23824 (SD); Sierra San Francisco, Mesa San Jorge, ca. 7-7.5 km W of San Francisco & 16 km SW of Santa Marta, 9 Jun. 1984, J. Dice 512, 515, 516 (CAS, MEXU, SD); Sierra de San Francisco, Masa San Jorge, ca. 4.21 km (by road) WSW of the Village of San Francisco de la Sierra, 23 Jun. 1986, C. Dice, 675 (GH, MO); Sierra de San Francisco, west of the town of San Francisco de La Sierra, along road to Rancho Sorpresa, 24 Apr. 1994, W. Hogdson 81854 (DES, SD); Sierra de San Francisco, west of the town of San Francisco de La Sierra, on the road to Rancho Sorpresa, 24 Apr. 1994, J. Rebmun 2627 (BBCMEX, SD); Sierra San Francisco, Cerro Bola, 3 Sept. 1995, W. Hogdson 9582, 9582a (DES, SD); Sierra de San Francisco, 23 Oct 1997, J. Rebmun s/n (HCIB, SD); West of Mulegé; cumbre de San Pedro between ex-mission Guadalupe and San Juan de las Pilas, 29 Oct. 1997, J. Rebmun 4716 (HCIB, SD); Sierra de San Francisco, 1.5 km al NW de Santa Ana, Nov. 2004, O. Baltasar s/n, (QME); Sierra de la Giganta, Campanamento de la Sabanilla del Mechudo, 11 Nov. 2007, J. L. León de la Luz 10539 (HCIB, SD); Hernández 2007 (QME).


Plant rhizomatous, subterranean stems growing in a horseshoe shape by branching always to the same side; bark reticulate forming pentagonal pyramids 0.5 cm deep, 1 cm wide. Leaf rosettes subsessile, 40 to 90 cm diam, 15 to 25 leaves per rosette. Leaves linear, 48 to 109 cm long, 0.7-1 cm wide, helicoidal, glaucous green, scabrid; leaf margins with two sizes of denticles, the larger ones separated ca. 0.5 mm; leaf bases triangular to long deltate, 6-7 cm long, 3-3.5 cm wide in the inferior part, 1.2-1.5 cm wide in the superior part, yellow straw to dark brown with age, persistent, recurved; leaf apex entire. Inflorescences paniculate, largely ovoid to largely ellipsoid, 0.8 to 2 m long, 40 to 42 cm wide; scapes 35 to 45 long, 0.8 to 1.3 cm diam at the base; scape bracts linear, 15 to 30 cm long, separated among them by 10 to 15 cm; inflorescence branches compound, 37 cm long, decreasing apically in size to 9 cm, pedunculated, with 2 branchlets at the base, all subtended by papery linear-lanceolate bracts, 14 cm long, decreasing apically in size to 1 cm; branchlets 3 to 8 cm long, the apical ones 8 to 15 cm long, all subtended by amplexicaule papery bracts, 7 to 10 mm long. Staminate flowers 2 to 3(4) per node, 3 to 3.5 mm diam, on pedicels 4 to 5 mm long, wider in the apex, articulate above the middle, surrounded by membranaceous bracteoles, 2 to 3 mm long, margins dentate; tepals lanceolate, 2 to 3 mm long, 1.5 mm wide, reflexed from the middle at maturity, white to creamy, the midvein yellow green; filament 1 to 1.2 mm long, anthers 0.8 to 1 mm long; ovary undeveloped, on a small stipe. Pistillate flowers 2 per node, 2 mm in diam, on pedicels 1.8 to 2 mm long, articulate around the middle, surrounded by membranaceous bracteoles 2 to 4 mm long, margins dentate; tepals lanceolate, 2 to 2.5 mm long, 1 to 1.5 mm wide, white to creamy with purple dots or blotches around the midvein; staminoids 1 mm long; ovary 1.5 to 2 mm diam, stigmas sessile, 3-lobulate. Fruits slightly depressed, 0.8 to 1 cm long, 1 to 1.2 cm wide, on peduncles 6 to 7 mm long, articulate below the middle; fruit lobes papery, brown with purple reddish spots at the middle, with weak margins; apical notch 2.5 to 3 mm deep; tepals persistent, the external ones reflexed. Seeds ovoid, asymmetrical, 4 to 4.5 mm long, 2 to 2.5 cm wide, grayish green to brown at maturity, microreticulate, puncate, and sometimes with papillate trichomes, hilum suprabasal with a conic caruncle. Figure 8.

Ecology and Distribution—This species grows in sandy to deep soils on slopes with gabbro outcrops, 340 to 460 m in elevation, in chaparral vegetation with Adenostoma fasciculatum Hook. & Arn., Arctostaphylos sp., Rhus ovata S. Watson and Ceanothus sp. The individuals of N. interrata can withstand periodic wildfires. It is an endemic and endangered species of San Diego County, California and the northwestern part of Baja California, Mexico (Fig. 2). The plants flower from April to August, and set fruits from August to October.
Plants cespitose forming clumps 3.5 m wide, acaulescent or with trunks 10 to 60 (–100) cm high, 10 cm diam; bark forming polygonal pyramids 1 to 1.5 cm deep, 1 to 2 (–2.5) cm wide.
Rosettes 12. Leaves linear, 90 to 116 cm long, 4 to 8 mm wide at the middle, concave in cross section; leaf base triangular, (5–9) to 11 cm long, (2–)4 to 7.5 cm wide below, (0.8–)1 to 1.6 cm wide above; leaf margin with translucent to brown denticles with the epidermis up growing in the middle; leaf tips coiled, becoming dry with a yellow straw color. Inflorescence 0.96 to 3 m cm high, 8 cm wide; scape 10 to 0.35 to 1 m long, 1 to 4 cm diam at the base with linear bracts, 8 to 50 cm long; the first 15 to 30 cm of the inflorescence bear the loose and thin branches 5 to 8 cm long; the rest of the branches stiff, erect to curved, ascending, 24 to 17 cm long, decreasing in size to 6 to 4 cm at the apex branch, subtended by linear to long triangular bracts.

shorter than the branches, from 16 cm long, decreasing to the apex to 2 cm, papery, the larger ones with tips coiled; branchlets 1–8 cm long, last part of branches beyond the last branching (4–)6 to 11 cm long. Staminate flowers 1(–2) per node, campanulate, 2.5 to 3.5 mm long, 4 to 5 mm wide, on pedicels to 1 mm long, articulated at the very base, surrounded by 2 widely lanceolate bracteoles, the external one 2 to 3 mm long, the internal one 1.5 to 2 mm long, white, membranaceous, margins lacinate to denticulate; tepals oblong to oblong-lanceolate, 2.5–3 mm long, 1–1.5 mm wide, reflexed from the middle at maturity; filaments 1 to 1.2 mm long, anthers 1–1.1 mm long. Pistillate flowers 1 to 2(–3) per node, campanulate, 2.5–3.5 mm long, 3–4 mm wide, on pedicels up to 2 mm long, articulated above the middle, surrounded by lanceolate bracteoles, the external ones 2–4 mm long, the internal ones 1.5–2 mm long, white, membranaceous, margins long lacinate to denticulate; tepals lanceolate, 2.2–2.5 mm long, 1–1.5 mm wide, white with the base thick, greenish, midvein reddish to brown; ovary round, 3 mm diameter, 3-lobed; ovules basal, subtended by a small, round or shelf-like protruding structure, which is flattened by the fertilized ovule growth; stigmas sessile, 3 branched. Fruit depressed to or-}

**Ecology and Distribution**—Nolina palmeri grows in canyons, on east and west slopes, crevices, ledges, and dry hills, on volcanic and granitic rocks, and granitic alluvium soils, 1250 to 2830 m in elevation (Fig. 10). It is part of the chaparral, and the pine, juniper, and oak forests, along with Adenostoma spp., Arctostaphylos pungens Kunth; Artemisia sp., Brahea armata S. Watson, Canthusus sp., Celtis ehrenbergiana (Klotzsch) Liebm., Condalia brandegeei I. M. Johnst., Cylindropuntia cholla (F. A. C. Weber) F. M. Knuth, Cylindropuntia alcalae (F. A. C. Weber) F. M. Knuth, Donodoea viscosa Jacq., Juniperus californica Carrière, Pinus Jeffreyi Grev. & Balf., P. contorta Loudon subsp. murrayana (Grev. & Balf.) Critch., Populus tremuloides Michx., Prosopis articulata S. Watson, Quercus spp., Salvia pachyphylla Munz, and Yucca schidigera Oertges. The flowers are visited by Hemiptera to lay eggs that hatch in June. The species flowers from April to June, and produces fruits from July to November.

**Nolina palmeri** is an endemic species to Baja California, and occurs sympatrically with *N. bigelovii* occurs sympatrically with state, and is distributed to the Sierra de La Libertad at its northwestern corner, at an elevation of 1250 to 2830 m in elevation (Fig. 10). It is part of the chaparral, and the pine, juniper, and oak forests, along with *Adenostoma* spp., *Arctostaphylos pungens* Kunth; *Artemisia* sp., *Brahea armata* S. Watson, *Canthusus* sp., *Celtis ehrenbergiana* (Klotzsch) Liebm., *Condalia brandegeei* I. M. Johnst., *Cylindropuntia cholla* (F. A. C. Weber) F. M. Knuth, *Donodoea viscosa* Jacq., *Juniperus californica* Carrière, *Pinus Jeffreyi* Grev. & Balf., *P. contorta* Loudon subsp. *murrayana* (Grev. & Balf.) Critch., *Populus tremuloides* Michx., *Prosopis articulata* S. Watson, *Quercus* spp., *Salvia pachyphylla* Munz, and *Yucca schidigera* Oertges. The flowers are visited by Hemiptera to lay eggs that hatch in June. The species flowers from April to June, and produces fruits from July to November.

**Nolina palmeri** is an endemic species to Baja California, and occurs sympatrically with *N. bigelovii* occurs sympatrically with the region.

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Species Possibly Present on the Baja California Peninsula—Two species, *Nolina cismontana* and *N. parryi* have not yet been discovered on the Baja California peninsula, but grow at a distance less than 50 miles north of it in San Diego County, California, USA (Hess 2002). It is very likely that either one of these species could occur in the Baja California region. We consider it important to include a small di-

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flowers 3 to 5 mm diam on pedicels erect, 3 to 5 mm long, articulate at or above the middle, surrounded by laciniate bractlets; tepals 2.5 to 5 mm long, staminoids 1–1.2 mm, anthers 0.4–0.6 mm; Staminate flowers 3 to 5 mm diam; filaments 2 to 4 mm long, anthers to 1.2 mm; Fruit 8.2–11.2 mm long, 9–12 mm wide, notched basally and apically. Seeds ovoid, 4 to 5 mm long, 3 to 4 mm wide, reddish brown, exposed at fruit maturity. Figure 11.

According to Hess (2002), *N. cismontana* flowers in early to mid-spring, and grows on rocky hillsides in dry chaparral of coastal mountains from 200 to 1300 m in elevation.
**Nolina parryi S. Watson**

Plants caulescent; rosettes from woody, branched caudices and forming small colonies. Stems 0.5 to 2.1 m. Leaves 65 to 220 per rosette; blade helicoidal, 50 to 140 cm long, 20 to 40 mm wide, rarely glaucous; bases spoon-shaped, 5–16.5 cm wide; margins denticulate. Scape 40–170 cm, 26–90 mm diam at base. Inflorescences 20 to 130 cm long, 9–18 cm wide; bracts persistent, 15 to 36 cm long, papery. Pistillate flowers 3 to 5.5 mm diam on pedicel erect, 3 to 4 mm long, articulated at or above the middle, surrounded by laciniate bractlets, to 10 mm, fragile; tepals 2.5 to 5 mm; staminoids 1–2.5 mm long, anthers 0.4 to 0.5 mm long. Staminate flowers 3–5.5 mm diam, stamens 3–4 mm, anthers 1.3–1.8 mm. Fruits 9 to 13 mm long.
8 to 11 mm wide, notched basally and apically. Seeds ovoid to oblong, 3–4 mm long, 2–3 mm wide, reddish brown, exposed at fruit maturity. Figure 11.

According to Hess (2002), *N. parryi* flowers in early spring and grows on rocky slopes of desert and pinyon-juniper woodlands from 900 to 2100 m in elevation.

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Author Contributions

Luis Hernández-Sandoval authored most of the taxonomic treatment as well as the Nolina historical context, and provided some field collections. Jon Rebman contributed to the species taxonomic descriptions, plant collections, and distribution decisions. He also contributed most of the plant photographs.

Literature Cited


