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Richard S. Felger
Drylands Institute

Elaine Joyal
Arizona State University

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THE PALMS (ARECACEAE) OF SONORA, MEXICO

RICHARD S. FELGER

Drylands Institute
2509 North Campbell #405
Tucson, Arizona 85719
e-mail: rfelger@ag.arizona.edu

AND

ELAINE JOYAL¹

Department of Botany
Arizona State University
Tempe, Arizona 85287
e-mail: joyal@asu.edu

ABSTRACT

This publication is an account of the palms (Arecaceae) in the state of Sonora in northwestern Mexico. Six native palm species in three genera are recorded for Sonora: *Brahea* with four species, and *Sabal* and *Washingtonia* each with one species. Relationships and taxonomy within *Brahea*, especially *B. elegans*, remain unresolved. Brief botanical descriptions, taxonomic synopses, local names, identification keys, conservation status and recommendations, and distributional and ethnobotanical information are provided for each species. Basionyms and types are cited. Distributions are documented with citations of nearly all herbarium specimens known to us from Sonora. Many palm populations in this arid and semiarid region are threatened by development and in some cases over-exploitation. There is an urgent need for formal management and conservation action for local populations, although as a whole none of these species in Sonora are rare or immediately threatened.

RESUMEN

Esta publicación es un estudio de las palmas (Arecaceae) en el estado de Sonora, en el noroeste de México. Se registran en Sonora seis especies nativas en tres géneros: *Brahea* con cuatro especies, y *Sabal* y *Washingtonia* ambos con una especie. Quedando sin resolverse las afinidades y la taxonomía dentro de *Brahea*, especialmente *B. elegans*. Para cada especie se proporcionan breves descripciones, sinopsis taxonómica, nombres locales, claves para la identificación, estado y recomendaciones de conservación e información sobre la etnobotánica y distribución. Se presentan basionimias e información sobre los tipos y sinónimos. Distribución con citas de casi todos los especímenes de herbario de las Arecáceas de Sonora conocidos por nosotros es proporcionada. Muchos de las poblaciones de palmas en este región árida y semi-árida son amenazadas por el desarrollo y en algunos casos por la sobre-explotación. Hay una necesidad urgente para el manejo formal y acción de conservación para poblaciones locales; sin embargo en general ninguna de las especies en Sonora se considera especialmente rara o en peligro inmediato.

Key words: Arecaceae, *Brahea*, *Erythea*, Mexico, palms, *Sabal*, Sonora, *Washingtonia*.

INTRODUCTION

Writing from Europe in the late 18th century, more than a decade after suffering through the Jesuit expulsion, Ignaz Pfefferkorn (1949: 74) stated: "Many palm trees grow in the region near the sea, especially in the vicinity of Guaymas. Since these palms neither yield fruit nor attain the height which is reached by genuine palms, they seem to be either degenerate or false mem-

bers of their family. Hence, they do not merit the space necessary to describe them." We disagree and devote this space to describing the magnificent palms of the state of Sonora, in northwestern Mexico.

The palms of northwestern Mexico have been poorly known due, at least partly, to their inaccessibility. Many Sonoran palm groves remain sheltered in secret canyons and hidden on remote mountains. In addition, there has been a paucity of field studies, field notes accompanying specimens, and "complete" herbarium collections (few have both flowers and fruits).

¹ Current address: Department of Anthropology, Arizona State University, Tempe, Arizona 85287-2402.

Table 1. Ecological distribution of palms in Sonora: Sonoran Desert (SD), tropical deciduous forest (TDF), tropical thornscrub (TTS), oak woodland (OAK), and pine-oak woodland or forest (PIN).

	SD	TDF	TTS	OAK	PIN
<i>Brahea aculeata</i> (Brandege) H.E. Moore		TDF		OAK	
<i>Brahea elegans</i> (Franceschi ex Becc.) H.E. Moore	SD		TTS	OAK	
<i>Brahea dulcis</i> Kunth		TDF			
<i>Brahea nitida</i> André	SD	TDF	TTS	OAK	PIN
<i>Phoenix dactylifera</i> L.	SD				
<i>Sabal uresana</i> Trel.	SD	TDF	TTS	OAK	
<i>Washingtonia robusta</i> H. Wendl.	SD				

The purpose of this work is to provide information on the natural history, ethnobotany, horticulture, distributions, and location of principal collections of Sonoran palms, and to help clarify their taxonomy and nomenclature. Palms in northwestern Mexico are keystone species, and we trust that this information will aid in efforts to conserve them and their special habitats.

DISTRIBUTION, DIVERSITY, AND ECOLOGY

Three genera and six species of palms are native to Sonora: *Brahea* with four species, and *Sabal* and *Washingtonia* each with one species (Table 1; Fig. 1). These are among the northernmost native palm genera in the Western Hemisphere. All are medium- to large-sized fan palms in the tribe Corypheae of the subfamily Coryphoideae. In addition, the date palm (*Phoenix dactylifera*) is occasionally encountered in noncultivated habitats.

Washingtonia occurs naturally northward to Arizona and California, whereas *Brahea* and *Washingtonia* occur in both states of Baja California (Wiggins 1964; Turner et al. 1995). *Washingtonia robusta*, restricted to a few riparian canyons at the southern edge of the Sonoran Desert, appears to be relictual in Sonora. It occurs naturally otherwise only in Baja California Sur. *Sabal uresana* scarcely extends beyond the confines of Sonora, whereas *Brahea elegans* is endemic to Sonora. *Brahea aculeata*, *B. dulcis* and *B. nitida* range southward in Mexico and *B. nitida* extends to Guatemala.

Palm species represent less than 2% of the tree flora of Sonora, which includes more than 275 species in a vascular flora of perhaps 5000 species (Felger and Johnson 1995; Felger and Wilson 1995). Palms in Sonora are distributed in a variety of habitats (Table 1). For discussion of Sonoran habitats see Brown (1982), Steinmann and Felger (1997), and Búrquez et al. (in press). Four Sonoran species occur within the Sonoran Desert as mapped by Shreve (1951). *Washingtonia robusta* occurs only in riparian habitats within the Sonoran Desert, and is geographically and ecologically the most narrowly restricted palm species in the state. In northern Sonora, about 100 km south of the Arizona

border, *Brahea nitida* occurs in riparian canyons at the uppermost edge of the Arizona Upland region of the Sonoran Desert at its ecotone with oak woodland. Four species occur in tropical deciduous forest and tropical thornscrub (Felger and Joyal 1998). Palms of non-desert habitats in Sonora commonly extend into the lower oak zones and sometimes even intermingle with pines in pine-oak woodland of eastern Sonora. Although some Sonoran populations are relatively widespread, most are highly localized and niche-specific.

Most of the inland groves contain only a single palm species, although in some places two or three species may occur together or in close proximity to each other. Where these palm species occur sympatrically, the maximum densities for each species are in somewhat different niches. Three species, *Brahea elegans*, *Sabal uresana*, and *Washingtonia robusta*, occur together in a number of the palm oases near the coast north of Guaymas in the Sierra El Aguaje and vicinity, e.g., Cañón del Nacapule (Felger 1999), Los Anegados, La Huerta (Ojo de Agua), and Cañón Las Barajitas. *Washingtonia robusta* is the most narrowly restricted, with the fewest number of plants, and concentrated closest to water sources. *Sabal uresana* occupies somewhat less restricted habitats and is more numerous, while *B. elegans* is the most widespread of the three and is truly abundant. Elsewhere in Sonora, *Sabal* sometimes occurs together with *B. aculeata* or *B. elegans*.

Apparent adaptations to aridity and/or winter freezing among palms of southwestern North America include larger (thicker) trunks and larger leaves with tougher and more reflective, duller-colored leaf blades. The two truly Sonoran Desert species, *Brahea armata* S. Watson and *Washingtonia filifera* (Linden) H. Wendl., have exceptionally thick trunks and dull-colored leaves. Their congeners to the south have more slender trunks and thinner, greener leaf blades. *Brahea aculeata* of southeastern Sonora and Sinaloa is smaller in stature and has smaller, thinner leaves than *B. elegans*, its northern, desert-edge and desert-inhabiting relative. A similar trend is seen among *Sabal* species in western Mexico (e.g., Zona 1990). These trends may also be intraspecific—the northernmost popula-

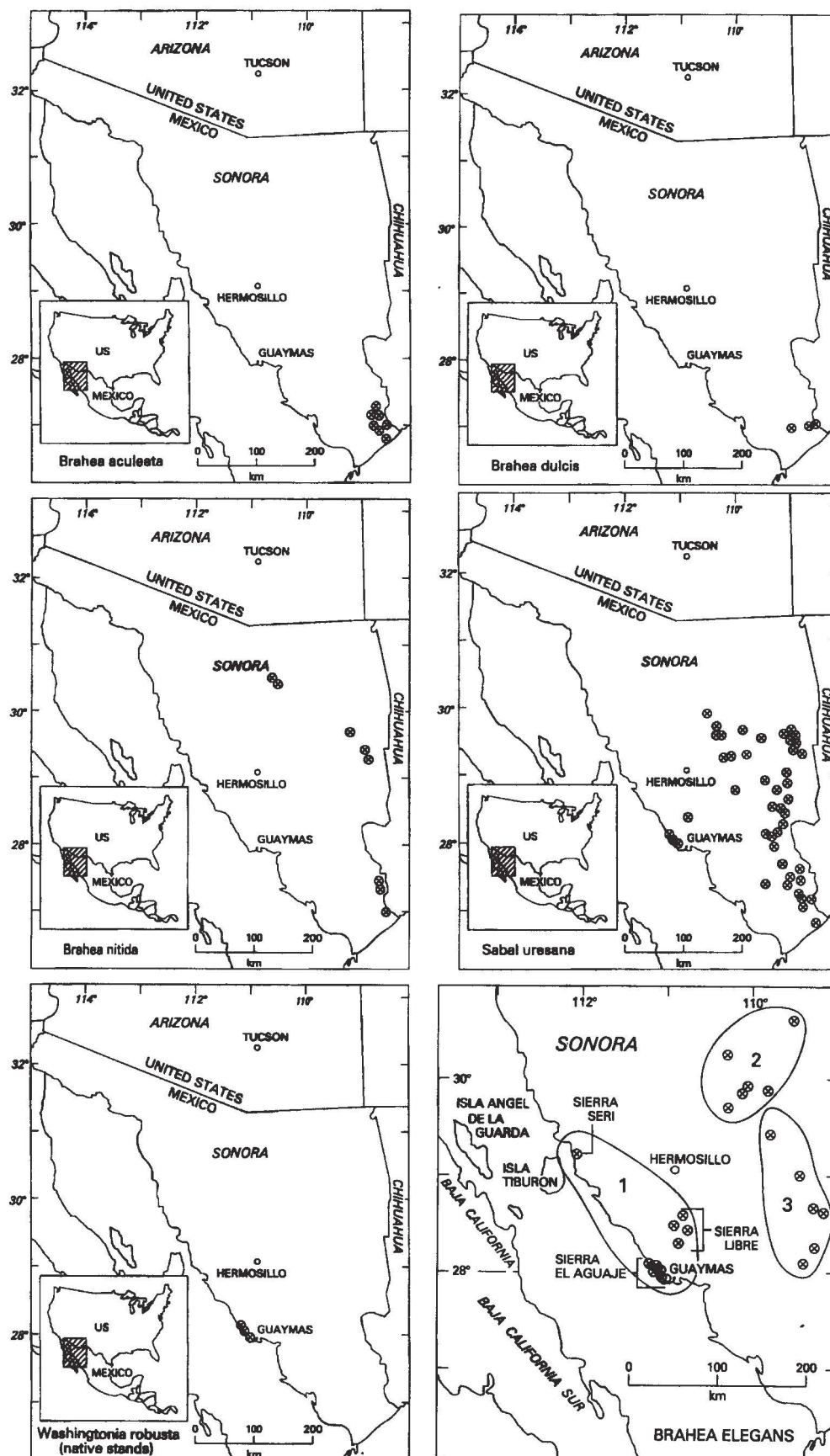


Fig. 1. Distributions of the native palms in Sonora, Mexico. The map of *Brahea elegans* shows the three major geographic populations. (1) Western Sonora, (2) north-central Sonora, and (3) east-central Sonora.

tions of *Brahea elegans* are larger and more robust than those farther south, and desert-inhabiting populations along the coast tend to have more glaucous leaves than those in the mountains of eastern Sonora.

PALMS AND PEOPLE IN SONORA

Palms are one of the most highly utilized plant families worldwide, especially in tropical regions. Sonora, at the edge of the tropics, is no exception. The most widely used part of Sonoran palms are the leaves which are or have been employed in weaving, thatching, and broom-making. The trunks have been used for construction, and the fruit and sometimes the palm heart for food (e.g., Rose 1899; Standley 1920; Gentry 1942, 1963; Pfefferkorn 1949; Hinton 1959, 1969; Di Peso and Matson 1965; Sobarzo 1966; Nentvig 1977; Pennington 1980; Felger and Moser 1985; Joyal 1996a). Although much traditional knowledge of palms in northwestern Mexico has been lost, considerable knowledge remains unrecorded as well as culturally robust (e.g., Joyal 1996a, b).

Sabal uresana, the most widespread Sonoran palm, is an important nontimber resource, and the most economically valuable of the six regional palm species. Although other palm species and a few palmlike monocots are mentioned in the literature, *Sabal* is the most commonly and consistently cited Sonoran palm in more than three centuries of historical references (Joyal 1996a).

The newly emerging, unexpanded palm leaf is called a *cojoyo* (this term is also used as a vulgar term for penis). Cojoyos, primarily of *Sabal*, are highly valued for weaving twilled and coiled baskets, mats, and other items, and people travel considerable distances to harvest them. *Sabal* is the only Sonoran palm employed in hat-making. The fully expanded leaves called *pencas*, especially those of *Sabal*, are widely used for broom-making. The leaves of *Sabal* and *Brahea aculeata* are extensively used for thatching. *Brahea aculeata* is also used to make mats by the Guarijío as well as other local people. Strips of leaf blades, especially of *Brahea aculeata* and to a lesser degree, those of *B. nitida*, are woven into a coarse cordage or rope and used for such purposes as tethering animals (Felger and David Yetman, unpublished field notes for Guarijío ethnobotany; Gentry 1942; Joyal 1996a).

Palm leaves, primarily *Sabal*, *Brahea aculeata*, and *B. nitida*, are traditionally harvested at the time of the full moon. The quality and durability is said to be compromised if the leaves are harvested at other times. However, harvesting does occur at other times, especially if for sale without regard for quality. Juvenile palms, called *palma del suelo* 'palm of-the ground,' are harvested for cojoyos for weaving mostly during the monsoon season. Leaves from mature palms, called

palma del taco "fruiting palm" in the case of *Sabal*, are mostly harvested for thatch in the spring dry season.

In the desert region, especially near Ures, the trunks of *Sabal* have been used to build corrals and as cross-beams (*vigas*) for houses. Traditionally only the trunks of dead trees were used to make corrals, but in recent years living trees have been cut, contrary to the policy of certain local forestry offices. Farther east and southward in the mountains, palm logs are occasionally used in construction and as benches, and are also hollowed out to make planters. During the 19th century the trunks of *Washingtonia robusta* were used in Guaymas "as rafters for houses. It is said to be a durable wood." (Rose 1899: 255).

The blackish, sugary mesocarp of the ripe fruit of *Sabal*, locally called *taco*, is eaten fresh in northeastern and east-central Sonora but is considered unpalatable in the desert area near Ures. The fruits of *Washingtonia* are sweet and edible, and apparently were used for food by the Seri (Felger and Moser 1985). In northeastern Baja California, the Cocopa people pit-roasted the large seeds of *Brahea armata* (Felger and Amadeo Rea, unpubl. 1980). Some *Brahea* species, especially *B. edulis* H. Wendl. ex. S. Watson from Guadalupe Island off the Pacific coast of Baja California, have a sweet, datelike mesocarp. The fruits of certain *Brahea* were used for food in Sonora, but the information is fragmentary. For example, the fruits of *B. aculeata* are eaten by the Guarijío (Felger and David Yetman, unpubl. 1997), and those of *B. elegans* are eaten in the Ures region (Joyal 1996a). However, especially in the case of the coastal palms north of Guaymas, the lack of ethnobotanical information is meaningless since indigenous people have not lived in the area for nearly one and one-half centuries and the information was not recorded (Felger and Moser 1985).

In the 17th century Nentvig (1672) reported the use of palm hearts (terminal buds) for food in northeastern Sonora. Gentry (1942, 1963) likewise reported that the Guarijío ate palm heart (*corazón*), apparently of *Sabal* and perhaps *Brahea aculeata*, a practice that kills the plant. Palm hearts are apparently no longer harvested in Sonora.

The fibers that hang between the leaflets of *Sabal uresana* were used by the Mountain Pima to weave saddle blankets. Orioles, including hooded and streaked-back, make nests from these fibers. These nests are sometimes used as sponges. *Sabal* petioles are employed to make racks for aging cheeses, stirring sticks, and broom handles.

Writing from Pópulo in 1692, Adamo Gilg mentioned that the Seri wove, "... mats of palms and reeds" (Di Peso and Matson 1965: 55). Pópulo was a Jesuit mission for the Seri during the 17th and 18th centuries along the Río Sonora near Ures; the palm

would have been *Sabal uresana*, which is common in the region. More than a century after the Seri no longer lived in places where palms occur (the coast north of Bahía San Carlos, northwest of Guaymas), the people still had knowledge of palms and their uses from that region (Felger and Moser 1985). Some hint of earlier palm use is found in the modern terms for any wooden box, *hehe zamij* “palm wood,” and the personal carrying box, *hehe zamij an iqui ihácalca* “box to put belongings in,” which have long been made from other kinds of wood. *Zamij* is the generic term for any palm including the introduced date palm. Seri oral history of the mid- to late 20th century included two kinds of native palms: *zamij cmaam* “female palm,” which most likely refers to *Brahea elegans*, and *zamij ctam* “male palm,” which most likely refers to *S. uresana* and/or *Washingtonia robusta*. The fruit of *zamij ctam* was eaten. A hat to provide protection from the sun was woven from tender, inner palm leaves. This kind of hat was called *zamij yeen haonam* “palm-face hat.” “Face” refers to the inner, or youngest leaf or cojoyo. Date palms, *Phoenix dactylifera*, brought to Sonora by the Jesuits during Spanish colonial times, have long been known to the Seri people. According to oral history, one Seri man planted dates at one or more camps south of Bahía Kino in the mid-19th century.

CONSERVATION AND MANAGEMENT

Three of the Sonoran palms are listed by the Mexican government on its most recent list of species needing protection (SEDESOL 1994). SEDESOL lists *Brahea aculeata* as “threatened, endemic,” *B. nitida* as “endangered,” and *Sabal uresana* as “rare, endemic.” SEDESOL did not list *B. dulcis*, *B. elegans*, or *Washingtonia robusta*. The SEDESOL determinations apply to a species’ status throughout Mexico.

Based on our field experiences in Sonora, we recommend the following IUCN 1997 Red List categories (Walter and Gillett 1998): *Brahea elegans* and *Sabal uresana* are endemic or nearly endemic in Sonora and most closely fit the IUCN criteria for Vulnerable (VU) status. The remaining four species largely fit the IUCN criteria for Lower Risk (LR), Near Threatened (NT) status in Sonora and Data Deficient (DD) in Mexico.

Both *B. aculeata* and *S. uresana* are still abundant in many places. Many of their populations are declining or extirpated due to overexploitation and habitat loss, primarily due to clearing of tropical deciduous forest habitat for buffelgrass (*Pennisetum ciliare* [L.] Link) pasture (Búrquez and Martínez-Yrizar 1997). In addition the oases and riparian canyons where palms occur are often heavily exploited for cattle grazing, settlements, and recreation. Cattle eat seedlings of *S. uresana* and probably other species too, especially dur-

ing spring drought if no other forage is available. *Brahea dulcis* and *B. nitida*, at least in Sonora, do not seem to be at risk, largely because they grow on inaccessible cliffs and in remote canyons. Individual groves or stands of *B. elegans* are vulnerable but countless thousands of them occur at higher elevations on remote, uninhabited mountains and on steep cliffs.

The palm canyons in the San Carlos–Bahía San Pedro region of central-coastal Sonora deserve vigorous management and protection. The more accessible, magnificent palm oases in the vicinity of Bahía San Carlos have been decimated by development, clearing of undergrowth, and removal of plants for landscaping (see *S. uresana* below). The *Sabal* grove, or *Palmar*, near the present Hotel Club Med, supported perhaps as many as 2000 adult palms in the 1960s and early 1970s. Today about 500 adult palms remain, but undergrowth vegetation has been destroyed and there is virtually no seedling survival. Unless there is a change to conservation management, these palm-dominated communities are essentially “living dead” sensu Janzen (1988). Other extensive palm groves, such as those in the canyons north of Bahía San Carlos, on the old road to Bahía Algodones, and at the San Carlos golf course, have been annihilated during the past few decades. No vestige remains of their former existence apart from an occasional lone palm.

The magnificent palm oasis at Cañón del Nacapule, supporting all three genera, is being devastated by mining of ornamental rock, cattle grazing, and vandalism (Felger 1999). However, many intact palm oases remain in this region (Sierra El Aguaje, from the vicinity of Bahía San Carlos to Bahía San Pedro; see Johnston 1924; Schnabel 1962, 1964; Felger 1966). The most extensive palm groves in the region are at Cañón Las Barajitas (between San Carlos and Bahía San Pedro), where all three genera are common.

Overharvesting has occurred at least since the 19th century (e.g., Gentry 1942). Rose (1899: 255) reported that “At Guaymas a few trees remain of the rare *Neowashingtonia sonorae* [= *W. robusta*], but most of them have been cut out.” Practices which ameliorate nonsustainable use of palms in Sonora include limiting access to populations on privately controlled property, “sparing” (not cutting living trees in agricultural fields and pasture), and restricting harvest according to lunar cycles. Choice of palm size and leaf age, and controlling harvest times (e.g., season as well as lunar cycle) further regulate leaf harvest (Joyal 1995, 1996b).

Throughout Sonora the dry dead leaves, or “skirts,” of palms are often purposely burned because they harbor nests of aggressive paper wasps (*Mischocyttarus* and *Polistes*). Palms generally recover from burning, which may be beneficial in destroying insect pests, opening up oasis vegetation, and increasing palm seed germination (Hicks 1989). However, many thriving

palm populations in Sonora occur in remote areas that are not burned by people, and in the case of *Sabal uresana* statewide only about 10% of trunks show signs of fire.

THE SONORAN PALMS

The following treatment of the Sonoran palm species is based on our field experience, study of herbarium specimens, and the literature. We have studied palm specimens and photos, especially those of northwestern Mexico, from the following herbaria: ARIZ, ASU, BCMEX, BH, CAS/DS, DES, FI, GH, HBG, MEXU, MO, P, RSA, SD, UC, UCR, and US. These collections include nearly all known Sonoran palm specimens. Unless otherwise noted, we have seen all specimens cited. The first set of Felger's specimens is at ARIZ and the second at MEXU, with additional duplicates when available at BH, FTG, CAS, etc. The first set of Joyal's specimens is at ARIZ and the second at MEXU, with additional duplicates at BH, US, and FTG. Specimen localities are listed by the present-day *municipio* (mpio.; see Steinmann and Felger [1997] for a map of Sonoran municipios).

In most instances heights of palms are visual estimates. Seed measurement for *Brahea* and *Washingtonia* include the thin and essentially inseparable endocarp. The thin endocarp of *Sabal uresana* does separate and the seeds were thus measured without the endocarp. The following keys and brief descriptions are based on palms from Sonora and might not apply to plants in other regions.

KEY TO THE GENERA

1. Plants often branching from the base (suckering); leaves pinnate; dioecious; seeds more than twice as long as wide, conspicuously grooved; date palm, cultivated, rarely surviving at abandoned settlements or marginally naturalized . . . *Phoenix*
- 1' Plants single-trunked; leaves palmate (fan palms); flowers bisexual; seeds less than twice as long as wide, not grooved; native palms.
2. Petioles always entire, the leaves prominently costapalmate (petiole extending well into blade on the lower surface), the hastula narrowly triangular, more than twice as long as wide, firm, and glabrous, the margins entire, persistent; inflorescences shorter than, or sometimes as long as the leaves; seeds broader than long, depressed globose . . . *Sabal*
- 2' Petioles entire or armed, the leaves not costapalmate or only moderately so, the hastula broadly triangular to irregular, broader than wide to less than twice as long as wide, the margins papery to variously pubescent, not entire, ultimately deciduous; inflorescences often longer than the leaves; seeds rounded to longer than broad.
3. Leaf blades often green above, silvery-blue glaucous beneath or tough and dull green or gray-green on both surfaces; sepals separate, entire; widespread . . . *Brahea*
- 3' Leaf blades shiny green on both surfaces; sepals united below, the lobes with ragged margins; in Sonora

native only in the Sierra El Aguaje and formerly at Guaymas *Washingtonia*

BRAHEA Mart. ex Endl., Genera Plantarum 252. 1837.

Northern Mexico, including both states of Baja California, to Central America; about 12 species, all occurring in Mexico (Quero 1992). Moore (1973) and Uhl and Dransfield (1987) consider *Brahea* and *Erythea* to be congeneric, although Quero (1989, 1992) treats them as distinct genera. These taxa are in need of taxonomic study (Uhl and Dransfield 1987).

Brahea sensu stricto includes five species ranging from Central America to northern Mexico excluding the Baja California peninsula. These palms are reported as being restricted to limestone substrates (Bailey 1943; Quero 1992), although this is not the case in Sonora for *B. dulcis* and some populations of *B. nitida*. The two species in Sonora are distinctive and not closely related.

Erythea S. Watson includes seven species (Quero 1992). Five of them are confined to northwestern Mexico, one occurs farther south in western Mexico, and another is in southern Mexico and Central America. They grow on soils derived from igneous rocks.

Erythea in Sonora is represented by a highly variable and taxonomically ill-defined complex of often isolated populations. Plants at the geographic and ecological extremes are quite distinctive but populations showing intermediate features are commonplace. A comprehensive study of *Erythea* is sorely needed but is outside the scope of this paper. We choose to treat the Sonoran taxa as two species within *Brahea*, while acknowledging that further research may result in a different arrangement and/or the circumscribing of new taxa.

Erythea was "one of the daughters of the Hesperides, daughters of the Evening or the West who, in Greek mythology, dwelt on an island on the western edge of the world and who guarded the golden apples there" (Bailey 1937: 85). Bailey suggested that Watson's choice of this poetic name indicated that Watson meant for *Erythea edulis* (H. Wendl. ex S. Watson) S. Watson, which is endemic to Guadalupe Island (about 500 km west of the then sparsely inhabited Pacific Coast of Baja California), to serve as the type species for the genus, and not *E. armata*, which he also transferred into the newly erected genus at that time. Bailey, however, never went so far as to designate *E. edulis* as the type species.

KEY TO THE SPECIES

1. Petioles unarmed or with small teeth near the base; fruits ovoid, 8.5–10 mm long (*Brahea* sensu stricto):
2. Hastula with a woolly or feltlike patch; flowering branchlets floriferous to their bases, densely pubescent, and at least 2.2–3.0 mm in diameter *B. dulcis*



Fig. 2. *Brahea aculeata* and *B. elegans* at Arizona-Sonora Desert Museum, Tucson. Grown from seed collected in 1970, and planted simultaneously in 1972 from one-gallon containers. *Brahea aculeata*, smaller palms on left, from the vicinity of Sabinito Sur, east of Alamos, and *B. elegans*, on right, from Cañón del Nacapule. Photo by R. S. F., April 1998.

- 2' Hastula glabrous; flowering branchlets not floriferous to their bases, sparsely or sometimes moderately pubescent, less than 1 mm in diameter *B. nitida*
 1' Petioles armed with small to large teeth; fruits globose, 16–30 mm in diameter (*Erythea*):
 3. Fresh fruits 25–30 mm maximum diameter ... *B. aculeata*
 3' Fresh fruits (15.8–)18.0–19.5 mm maximum diameter *B. elegans*

BRAHEA ACULEATA (Brandeggee) H. E. Moore, *Principes* 24: 91. 1980. *Erythea aculeata* Brandeggee, *Zoe* 5: 196. 1905.—TYPE: Mexico, Sinaloa, Cofradia, vicinity of Culiacán, 26 Oct 1904, Brandeggee s.n. (holotype UC 124999!). Fig. 2.

Vernacular names.—*Palmilla*. *Tajcú* (Guarijío). *Ta'aco* (Mayo).

Description.—Trunks mostly 2–9 m tall, 12.7–25 cm in diameter. Leaves often 10–30 in number, often 95–180 cm long; petioles commonly about as long as the leaf blade, 39–116 cm long, 0.7–1.9 cm wide just below the blade, armed with mostly stout, often yellow,

single and sometimes also double marginal teeth 1–6 mm long, often fewer and reduced apically, or sometimes young plants and smaller-leaved adult plants with the teeth greatly reduced or essentially absent; hastula small, hyaline; blades often 55–90 cm long, 60–110 cm wide, glaucous bluish-green, especially below and slightly greener above, often discoloring with darker blotches upon drying.

Inflorescences about equal to, or longer than the leaves, the branches and rachillae sparsely to densely tomentose. Rachillae (3–)5–11 cm long. Flowers white, very fragrant (at least in the late afternoon), the buds 1, 2, or 3 together, usually only 1 developing into a flower. Sepals 1 mm long, broadly triangular, greenish white. Petals 1 mm long. Petals, staminal ring, and anthers white. Ovary green, 3-lobed. Fresh fruits 25–30 mm maximum diameter, nearly round, the surfaces smooth, yellow-brown and somewhat mottled. Seeds 15.5–20.0 mm maximum diameter, rounded or nearly so. $2n = 36$ (Read 1964). Flowering recorded March to May, the fruits often ripe in March of the following year.

Distribution.—Valleys, hills, mountains, and canyon bottoms and slopes, the distribution decidedly patchy but the plants often locally abundant. Tropical deciduous forest and lower oak woodland, and sometimes extending into higher elevation zones in oak woodland and lower pine-oak woodland; Río Mayo and Río Fuerte drainages in the Municipio de Alamos, southeastern Sonora, ca. 320–1500 m. Populations slightly farther north along the Río Mayo, in the vicinity of Los Bajíos, in the Municipio de Quiriego may be *B. aculeata*. Likewise a sterile specimen from the vicinity of La Quema, in the Río Yaqui drainage, in the Municipio de Yécora, appears to be *B. aculeata*. Also southwestern Chihuahua, Sinaloa, and Durango.

Notes and horticulture.—This palm is readily grown from seed and is sometimes cultivated in southern Arizona. Plants more than 25 years old at the Arizona-Sonora Desert Museum west of Tucson have shown no signs of freeze damage. The precise northern limit for *B. aculeata* and its relationship to the southernmost *B. elegans* remains unresolved. Both in cultivation and in their natural habitats *B. aculeata* is a much smaller palm but with larger fruits and usually larger seeds. Grown side by side, these palms demonstrate clear differences in size and growth rates (Fig. 2).

Specimens examined.—MPIO. ALAMOS: Arroyo Gochico, ca. 9 km E of San Bernardo, 860 m, *Fishbein* 2165 et al. (ARIZ). 2.1 mi by road SW of Sabino (NE of Alamos), *Felger* 5023 (ARIZ). 15.4–15 mi E of Alamos, first drainage E of El Palmarito, 480–500 m, 27°02–03'N, 108°47'W, *Joyal* et al. 1426, 1427, 1428 (ARIZ). Los Llanos, NE of Sabinito Sur, ENE of Alamos, *Joyal* 2401 (ARIZ). El Palmarito Canyon, between Sabinito Sur and Santa Bárbara, 27°04'N, 108°45'N, 580 m, *Jenkins* 93–89 (ARIZ). 14.6 mi E of Alamos, E of El Palmarito, 27°02–03'N, 108°47'W, 480–500 m,



Fig. 3. *Brahea dulcis* Rancho Santa Bárbara. Photo by E. J., May 1990.

Joyal et al. 1425 (ARIZ). 1 km S of Rancho Santa Bárbara, Jenkins 93-41 (ARIZ). Ca. 0.5 km N of Las Plomosas, 7 km by road eastward from Sabanitas, vicinity 26°59'45"N, 108°45'W, 400 m, Felger 90-682 (ARIZ). Rancho San Pedro, 27°02.5'N, 108°43'W, 450 m, 8 Nov 1988, Martin s.n. (ARIZ). 11 mi E of Alamos, 1960-61, Weber s.n. (BH). 16.1 mi SE of Alamos along road to Milpillas, Boutin & Kimmach 3617, 3618 (BH). 21.7 mi by road NE of Alamos on road to Milpillas, Felger 5568 (ARIZ). 40 mi E of Alamos, Feb 1961, Nelson & Smith s.n. (BH). Upper crossing of the Rio Cuchujaqui, 7 mi ESE of Alamos, 26°59'N, 108°50'W, 1300 ft, ca. 1 mi upstream from road crossing, Sanders 1093A (UCR). Rio Cuchujaqui, upper crossing near Lajitas, 8.9 mi ESE of Alamos, 26°59'N, 108°49'W, 320 m, Starr 470 (ARIZ). Rancho Agua Nueva, 1450 ft, Boutin & Kimmach 3711, 3712, 3714, 3715 (BH). Sierra de la Ventana, 3000-4000 ft, oak-nolina-grassland, Gentry 21179 (ASU). Guirocoba: Valley slopes and lateral arroyos with patched woodland formation, Gentry 4919 (ARIZ, DS, GH); Gentry 5959 (ARIZ, BH, DS, GH); Rancho Giricollí [probably = Guirocoba], 30 mi S of Alamos, 1938, Lindsay s.n. (BH). 7.0 mi by road N of Guirocoba, upper edge of short-tree forest, 13 Apr 1989, Salmon s.n. (ARIZ).

BRAHEA DULCIS (Kunth) Mart., *Hist. Nat. Palm.* 3: 244. 1838. *Corypha dulcis* Kunth, Nov. Gen. Sp. 1 [quarto]: 300. 1815.—TYPE: Amerique Equatoriale, Bonpland 3938 (holotype P!).

Fig. 3.

Vernacular name.—*Palma ceniza* "ashy palm," used at Los Bajíos by Guarijío men "for a palm that grows to the east up in the mountains," apparently this species.

Description.—Solitary palms, often to 5+ m tall, the trunk often 10+ cm in diameter, the older leaves falling away. Leaves reaching ca. 125 cm long, the petioles 52-80+ cm long, usually entire apically and with some broad teeth basally often 1-1.5 mm long, glaucous, 14-25 mm wide near base, tapering to 8-15 mm just below the blade; hastula as wide or wider than long, to ca. 1.5 cm long, thin, brown, scarious and fraying into fibers; blades often 65-85 cm long, about as wide as long, shiny green above, glaucous-blue below, with deciduous, sordid, sparse tomentum on the segment midribs near the base of the blade on both surfaces, this tomentum and the hastula usually wearing away with age.

Inflorescences arching, usually longer (sometimes twice as long) than the leaves, 4-times branched; flowering branches and rachillae crowded, purple-brown, often becoming cream-colored and very densely woolly-tomentose; branching angles acute. Rachillae catkinlike, floriferous to their bases, 4-10 cm long, 2.2-3.0 mm in diameter. Flowers greenish white, spirally arranged, not paired or clustered (more or less equally spaced from one another), the buds longer than wide, the flower bases submerged in the woolly hairs of the rachillae. Sepals ca. 1 mm long, overlapping, short woolly (tomentose-canescient) on exposed surfaces, the margins scarious. Petals 2.3-2.4 mm long, glabrous except sometimes sparsely canescient with some small hairs basally, striate (longitudinal lines formed by prominent veins). Filaments slender from broadly expanded, thick, deltoid bases. Young fruits densely pubescent with short hairs. Fruits with a fleshy pericarp, smooth, purplish black when ripe, rounded, 10.5-12.5 mm in diameter, glabrous or sparsely pubescent at base, wrinkling on drying, 8.5-11.5 mm in diameter. Seeds brown, 6.5-9.0 mm long, broadly ovoid. Flowering as early as March, but mostly June and July. Mature fruits found in January and February.

Distribution.—In Sonora known for certain from Sierra de Alamos, and two remote areas farther east along the Río Cuchujaqui drainage in the southeastern part of the state at 700-1400 m. Often growing out of rock crevices on precipitous cliffs and canyon walls, including south-facing cliffs, cliff tops, moist slopes, and riparian canyons; at the upper elevational limits of tropical deciduous forest, and oak woodland, or the lower limits of pine-oak woodland. The substrates do not seem to be limestone, unlike those of populations elsewhere in Mexico. The Sonoran *B. dulcis* is not in cultivation.

Sonora and northeastern Mexico to Central Ameri-

ca. Probably also in southwestern Chihuahua but not documented from that state. *Brahea dulcis* is quite variable across its entire range and there may be more than one taxon involved.

Specimens examined.—MPIO. ALAMOS: Sierra de Alamos: S-facing cliff above Cañón Saucito, 1300 m, *Fishbein 1610 et al.* (ARIZ); Cañón de Bolsa (Cañón las Piedras), 1450 m, *Fishbein 1922 et al.* (ARIZ); La Huerta (abandoned) on "magnolia trail," 1100 m, *Jenkins 88–297* (ARIZ); Above el puente de La Huerta (a saddle above La Huerta) on the trail to El Pinal Grande and Aduana Peak, near 26°59'N, 108°58.6'W, 1300–1450 m, *Sanders 13490 et al.* (ARIZ, UCR); N side of S. de Alamos, 15 Jun 1996, *Larson s.n.* (ARIZ). Vicinity of Puerta de Mano [ca. 1 km S from Choquincabui, N of Guirocoba], 700 m, 26°59'N, 108°39'W, 26 Dec 1988, *Salmon s.n.* (ARIZ). Rancho Santa Bárbara, el valle San Felipe, Río Cuchujaqui drainage, ca. 25 km by air ENE Alamos: stream bottom below oak-pine forest, 27°05.5'N, 108°42.5'W, 750–800 m, *Joyal et al. 1443* (ARIZ); oak-pine forest, 27°06.8'N, 108°42.2'W, ca. 1400 m, *Joyal 1492, 1494* (ARIZ).

BRAHEA ELEGANS (Franceschi ex Becc.) H. E. Moore, *Baileya* 19: 168. 1975. *Erythea elegans* Franceschi ex Becc., *Webbia* 2: 138. 1907.—TYPE: U.S.A., California, "leaf from the original plant in Los Angeles (this old palm has always been closely shaded by overhanging tree), spadix from original in Los Angeles (the mature fruit fell from this spadix when I cut it)," 13 Sep 1913, *J. Harrison Wright s.n.* (holotype, FI, not seen; [the specimen is accompanied by correspondence from Wright to Beccari]; photos ARIZ!, BH!, MEXU!). Also see additional notes and specimens cited below. Fig. 4, 5.

Brahea clara (L. H. Bailey) Espejo & López-Ferrari, *Sida* 15: 617. 1993. *Erythea clara* L. H. Bailey, *Gentes Herb.* 6: 197, Fig. 69. 1943.—TYPE: Mexico, Sonora, Nacapule Canyon near Guaymas, 14 April 1936, *Bailey 263* (holotype, BH!).

Vernacular names.—*Babiso* (north-central Sonora). *Coguegue* (central Sonora). *Palmilla* (central Sonora). *Mahajam stutum* (Pima Bajo; *Rea 871*). *Zamij cmaam* (Seri; Felger and Moser 1985).

Description.—Medium to large palms, the trunks often 6–12(–ca. 20) m tall, 16–33 cm in diameter. Petioles often 80–135 cm long, armed with teeth reaching 7.5–8.5 mm long, these usually stout, curved or straight, solitary or double. Hastula to about 3 cm long, often hyaline, the sides unequal, irregularly narrowed or pointed. Leaves about 40 or fewer in number, the blades often approx. 1 m long, strongly glaucous with much variation in leaf color and indumentum, from green to silvery glaucous.

Inflorescences 10–12 per tree, mostly longer than the leaves, 205–340 cm long. Bractlets 1.0–1.5 mm long. Flowers (1)2 or 3 in clusters. Sepals 1 mm long, thin, cupped, broad, and scarious. Corollas sympetalous below, the lobes 1.6 mm long, thick and broadly deltoid. Filaments short and slender. Fruits rounded, (15.8–)18.0–19.5 mm maximum diameter. Seeds 14.5–



Fig. 4. *Brahea elegans*. West-central Sonora, Cañón Las Barajas. The tallest palm is *Sabal uresana*, the others are *B. elegans*. Photo by R. S. F., 1995.

19.0 mm maximum diameter, nearly rounded or with the maximum diameter 10–20% larger than the minimum diameter. Mostly flowering in late spring, the fruits ripening the following spring.

Distribution.—This palm is endemic to Sonora, and shows considerable variation across its geographic range. Future studies may reveal geographic variation that could warrant infraspecific recognition.

Populations in the northeastern part of the range in Sonora occur at the upper elevations of the Sonoran Desert, while at their southeastern limits these palms occur in tropical thornscrub and the northernmost limits of tropical deciduous forest. At the higher elevations, throughout eastern Sonora, this palm extends into the lowermost oak zones.

We distinguish three populations which are geographically definable (Fig. 1). There appear to be morphological differences in trunk and leaf size, and color and indument of leaf blades. These are as follows:

Western Sonora.—Hesper palms occur in three areas in western Sonora—from the Sierra El Aguaje and vicinity northward to the Sierra Seri. These palms are generally large and robust, especially compared with



Fig. 5. *Brahea elegans*. North-central Sonora, Sierra de Nacozari, upper margin of Sonoran Desert and oak woodland vegetation with many riparian species; collection site for Felger *et al.* 3288. Photo by R. S. F., June 1960.

those in east-central Sonora but seem to be somewhat less robust than those of northeastern Sonora. The leaf blades are generally tougher and much duller ("whiter") than those of the east-central and northeastern Sonora populations.

Many thousands or perhaps millions of hesper palms occur in and about the rhyolitic Sierra El Aguaje between Bahía San Carlos in the south and the vicinity of Bahía San Pedro in the north. These palms range across many habitats such as canyon bottoms, steep slopes, rock clefts, and cliffs, including sea cliffs, and sometimes extend onto upper beaches and beach dunes. Numerous palms grow out of crevices in otherwise solid rock and on north- as well as south-facing slopes, and they are especially abundant in the higher mountain mass (the summit is ca. 860 m). Among the larger groves, such as in Cañón del Nacapule and Cañón Las Barajitas (Fig. 4), there is considerable variation in leaf color, ranging from green-leaved plants to the much more common dull, more glaucous- or whitish-leaved plants. In this region *B. elegans* often grows alongside *Sabal* and/or *Washingtonia* in riparian canyons and low-elevation palm groves.

An even larger population occurs in similar habitats in the Sierra Libre where they are likewise abundant at higher elevations across the main mountain mass.

These palms grow in riparian canyons such as La Pintada at the western base of the range to peak elevation at ca. 1160 m. No other palm species is known from this range.

The most isolated and undoubtedly the smallest palm population in Sonora occurs on a north-facing slope below Pico Johnson in the Sierra Seri. There are probably fewer than one dozen of these palms, hidden from view and far from any road. The colony includes juvenile and adult plants. Known to us only from photographs taken in 1988, they appear indistinguishable from the Sierra El Aguaje hesper palms about 185 km to the south. No palms occur farther north in the desert of western Sonora.

During the 1970s a Seri fisherman brought Mary Beck Moser an immature *Brahea* leaf which he claimed he obtained from a single plant on the west side of Isla Tiburón. Other Seri people also knew of this palm. Repeated attempts by Felger, even with aerial searches, have failed to locate this plant. Narrow, slotlike canyons on the west coast of this large island might shelter a palm, but the region is extremely arid and hardly seems suitable habitat for palms (see Felger and Moser 1985). However, *B. armata* does occur in semiriparian canyons on the not-too-distant Isla Angel

de la Guarda. Strangely, the Seri did not tell Moser or Felger about the isolated colony in the Sierra Seri.

North-central Sonora.—These are the northernmost hesper palms in Sonora, occurring within the Río Sonora drainage. They are scattered in localized populations in the Sierra Aconchi between Ures and Nacozari, and north through the Sierra to the valley bottoms near Arizpe (Fig. 5). Some are planted in the town of Arizpe. They have relatively green leaves and are strikingly large and robust, often reaching 18 m in height. From a distance these palms might be mistaken for *Washingtonia robusta*. They appear to be morphologically continuous with the increasingly smaller hesper palms farther south in east-central Sonora.

East-central Sonora.—Numerous, mostly widely scattered, and often small groups of these palms occur in eastern Sonora from the vicinity of Onavas and Nuri northward to the vicinity of Moctezuma. The region is entirely in the Río Yaqui drainage. Some of these palms can be seen from Highway 16 (the Hermosillo-Yécora road) in the vicinity of El Palmar de Onavas and Agua Amarilla. The southernmost of these palms approach *B. aculeata* in appearance but seem to be larger in overall size, and bear the smaller fruits characteristic of *B. elegans*.

Horticulture.—Plants grown from seeds, most often obtained in the Sierra El Aguaje region, are occasionally grown in southern Arizona and Sonora. This palm is relatively slow-growing, and thrives under cultivation in the Sonoran Desert, tolerating freezing weather in Tucson without damage. It is worthy of wide cultivation in very hot climates.

Notes.—The source plant for the type of *Erythea elegans* Franceschi ex Becc. was a cultivated palm grown from seed said to have been collected about 25 years earlier by a miner “in the vicinity of Hermosillo” (Beccari 1907). The type specimen has spiny petioles, glaucous leaves, and mature fruits 1.7–1.8 cm long. Wright’s letter to Beccari pointed out that the source plant (the Buddington plant, Los Angeles, CA) and other plants grown from its seeds were different from the Baja Californian *E. armata* and *E. brandegeei* (Purpus) H.E. Moore.

Based on its cultivation in southern California in the late 19th and early 20th centuries, *B. elegans* was reported to be dwarf in habit and slow-growing. In fact plants from the hot desert of Sonora often are stunted when cultivated in the nondesert regions of California (see Bailey 1937).

Hesper palms in western Sonora have also been called *B. roezlii* Linden (e.g., Wiggins 1964), likewise based on a poorly documented cultivated specimen. Bailey (1943) showed *B. roezlii* to be a synonym of *B. armata* of Baja California.

The relationships with the geographically neighboring hesper palms, *B. aculeata*, *B. armata*, and *B. brandegeei* remain unresolved. The hesper palm of western Sonora is distinguished from *B. armata* by its more slender trunk, generally greener (not as “white” or “silvery”) leaves that are more variable in color, and smaller inflorescences. However, some cultivated hesper palms at the Huntington Botanical Gardens in southern California, grown from seed obtained in the vicinity of Bahía San Carlos, are exceptionally robust and approach *B. armata* in gross appearance. Henderson et al. (1995) show *B. armata* in northwestern Sonora in a region where there are no native palms. *Brahea armata* is endemic to Baja California and Isla Ángel de la Guarda in the Gulf of California.

Brahea brandegeei was considered to be endemic to the Cape Region in southern Baja California Sur prior to the field guide by Henderson et al. (1995). Wendy Hodgson and Jon Rebman found a large population of hesper palms in the Sierra San Francisco, in northeastern Baja California Sur (Hodgson & Rebman 8171, ASU, BCMEX, DES). Are the Sierra San Francisco palms conspecific with *B. brandegeei* s.s. and/or the Sierra El Aguaje palms? Henderson et al. (1995) list *B. elegans* as a synonym of *B. brandegeei* but offer no explanation for their decision. The Sierra San Francisco hesper palms grow among Sonoran Desert vegetation in deep semiriparian canyons. Unlike their Sonoran counterparts, they seem to be confined to canyon bottoms and there appears to be a larger percentage of very tall palms. *Brahea brandegeei* from the Cape Region of Baja California Sur seems to differ from the Sierra San Francisco and western Sonora plants by having generally greener and thinner leaves and other characters cited by Bailey (1937) including inflorescences only as long as or shorter than the leaves. These characteristics, however, have not been quantified or studied in depth.

Specimens examined.—CALIFORNIA (cultivated): Buddington’s garden, Los Angeles, Wright & Jones s.n. (BH, photos of source plant). Photographs among papers of M. E. Jones of “Franceschi’s type plant, Buddington’s garden, Los Angeles, California,” later sent to H. Moore by G. H. M. Lawrence, Hunt Botanical Library (BH). Mrs. A. Buddington [residence], Alpine St., Los Angeles, supposed original tree of Franceschi, 25 Aug 1927, 1 May 1928, Braunton, s.n. (BH! [specimen and photographs]). Riverside, J. Harrison Wright’s grounds, 4 Mar 1927, Bailey 9255 (BH), and 31 May 1927, Bailey 9257 (BH).—SONORA: MPIO. BACANORA: Rancho El Torreoncito, W of Bacanora, 950–1000 m, Joyal 2223 (ARIZ)—MPIO. CUMPAS: 10 mi from Cumpas on rd to Baviácora, Wiggins 7423 (DS, US).—MPIO. LA COLORADA: E of La Palma, 50 mi N of Guaymas, Sierra Libre, Wiggins 6481 (DS, US).—MPIO. GUAYMAS: Palmar, a canyon opening eastward from the Gulf of California, 24 mi north of Guaymas near San Pedro Bay, *Sabal uresana* in same canyon, attractive grove coming down to the beach and extending up the canyon, also on cliffs, Bailey 2 (BH). 14.1 km N of Bahía San Carlos, ca. 3.2 km from the ocean, steep canyon with spring, stream, and palm oasis, 100 m, Boutin 2017, 2018 (BH, HBG). Cañón del Nacapule (Nacapule Canyon), ca. 4 km N of Bahía San Carlos,

28°00'56"N, 111°02'58"W, 150 m at entrance: 30 Mar 1934, *Bailey 4* (BH); *Felger 3382, 11985* (ARIZ); *Parfitt 3027, 3030* (ASU); *Starr 490* (ARIZ); *Yatskievych 82-48* (ARIZ). S slope in a large grove of *Erytheas*, 5.5 km NE up a canyon starting 22.1 km NW of San Carlos Bay, ca. 7 km from the ocean, *Boutin 2688* (BH, HBG). San Pedro Bay: *Moran 4037* (BH); Ravines in hills about bay, associated with but much less common than a *Sabal* sp., *Johnston 4340* (CAS, US). Bahía San Carlos (San Carlos Bay): Few scattered trees among a *Sabal* colony, broad canyon, *Johnston 4349* (CAS); Inland side of the main highway, *Zona et al. 258* (RSA). La Huerta, *Felger 3069* (ARIZ). Sierra Libre, 32 mi S of Hermosillo, 28°24'N, 110°58'W, 300 m, *Starr 753* (ARIZ).—MPIO. HERMOSILLO: Cañón La Pintada, 33 mi on Mex Hwy 15 south of Hermosillo, then 3.9 mi by road E of La Pintada, deep riparian canyon, *Felger 3262* (ARIZ). Sierra Seri, N side Pico de Johnson, less than 500 ft from summit, 15 Ap 1988, *Caugill* (photo: ARIZ, BH, MEXU). Vicinity of Hermosillo, 7 Mar 1910, *Rose et al. 12519* (BH [undoubtedly cultivated]).—MPIO. NACAZARI: Sierra de Nacozari, 3900 ft, 11 mi by road to Angostura and Oputo east of Esqueda-Nacozari road, then by foot ca. 1 mi S, riparian canyon, *Felger et al. 3288* (ARIZ).—MPIO. ROSARIO TESOPACO: 19.4–19.6 mi (by road) N of river crossing at Nuri (Palm Valley), wooded slope, 1840 ft, *Reeves et al. L18639* (ASU); *Turner et al. 75-62a* (ARIZ). 0.7 mi N of Las Cuestas on road from Rosario to Nuri, 535 m, *Zona 261* (RSA).—MPIO. SAN PEDRO DE LA CUEVA: 13 mi NW of San Pedro de la Cueva, *Wiggins 7513* (DS, US).—MPIO. URES: W flank of Sierra Aconchi, ca. 20 km NNE of Ures, Rancho El Estribo, 700–900 m, *Joyal 2497* (ARIZ).—MPIO. YÉCORA: 20.7–23.4 mi NE of Nuri, 540 m, *Boutin & Kimnach 3396-3699* (BH, HBG). Rancho Los Paredones, W of Tepoca, 28°28'N, 109°18'W, 750–800 m, *Joyal et al. 1670* (ARIZ). Ca. 20 km E of Onavas: Rancho El Palmar, *Joyal 1630* (ARIZ); Punta La Pila [= Agua Amarilla], drainage above "El Palmar," ca. 800 m, *Joyal 1579, 1581, 1607* (ARIZ). NE of Rancho Palmar, arroyo E of Onavas, *Rea 871* (ARIZ).

BRAHEA NITIDA André, *Revue Horticole* 344. 1887.—
TYPE: Illus., André, *Revue Horticole* 344, Fig. 67, 68, 69, 70. 1887. Figs. 6, 7.

Brahea prominens L. H. Bailey, *Gentes Herb.* 6: 192, Fig. 92C, 93D, 94D, 96–98. 1943.—TYPE: Mexico, [Oaxaca], park, Oaxaca de Juárez, 16 Mar 1940, *Bailey 533* (holotype BH!).

Vernacular names.—*Babiso* (vicinity of Nacori Chico and Cucurpe). *Jabehui* (Río Satachic). *Palma liza* "smooth palm" (name given at Los Bajíos "for a palm that grows to the east up in the mountains"). *Metajcu* (Guarijío).

Description.—Graceful palms, the trunk to ca. 10 m tall, usually much shorter, and 15.5–ca. 30 cm in diameter. Petioles entire or sometimes with a few minute teeth near the base, bluish glaucous, about as long as the blades, 1.6–4 cm wide the near base, tapering to 1.1–2 cm wide near the blade; hastula often 3–5 mm long, glabrous or ciliate. Leaf blades of larger trees ca. 80–100 cm long, slightly wider than long, relatively flat, shiny green above, bluish glaucous below, the segments divided to about half way, with a very slender, brown, curled fiber in the sinus of each leaf segment.

Inflorescences arching, often reaching ca. 2.0–2.3 m long, 4-times branched; inflorescence branches and

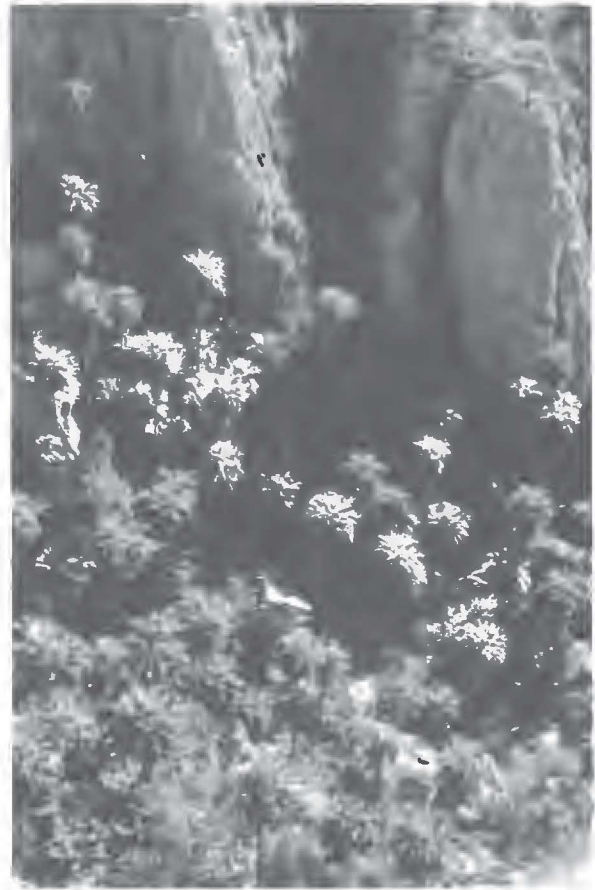


Fig. 6. *Brahea nitida*. North-central Sonora, portion of upper part of El Baviso or Palm Canyon, Sierra Baviso, southeast of Magdalena. Photo by George Ferguson, 1985.

branchlets (includes rachillae) with fine, whitish hairs. Rachillae floriferous nearly to their bases, 20–56 mm long, 0.7–0.9 mm in diameter. Flowers sessile, subtended by minute, broadly deltoid bractlets with acute tips. Calyces 1.2–1.5 mm long, cuplike, the sepals imbricate, separate, broadly triangular, very thick towards the base, puberulent with short, thick, white hairs. Petals 2.2–2.8 mm long, with sparse hairs below like those of the calyx, valvate in bud, slightly cupped near the apex, faintly indented (grooved) to accommodate the anthers, the filaments only united basally, broadly triangular with the upper portion slender and free. Young fruits pubescent; mature fruits 11.0–13.0 mm long, 8.5–9.0 mm maximum width, broadly ellipsoid, smooth and yellow-brown to purplish when fresh with a thin fleshy pericarp, wrinkled when dry, and often with short, sparse hairs near the base, otherwise glabrous. Seeds 8.3–11.0 mm long, 6.4–7.2 mm maximum width, ovoid-ellipsoid, light brown, smooth. Flowering primarily June and July; fruits mature late July of the same season, at least among northern Sonora populations.

Distribution.—Eastern Sonora, 945–1645 m. Mountain regions, often on limestone but sometimes appar-



Fig. 7. *Brahea nitida*. Northeastern Sonora, Rancho Pinalito, Sierra Torro Muerto. Photo by E. J., August 1993.

ently also on rhyolite; growing in crevices or among rocks on steep slopes, sheer cliffs, and canyon walls, and less often along canyon bottoms. The northernmost populations are in riparian canyons in Sonoran Desert-oak woodland ecotone in northeastern and north-central Sonora (Fig. 6, 7). This palm also occurs in widely scattered mountain canyons east of the Sonoran Desert. In southeastern Sonora it is sometimes common in narrow, riparian canyons and on cliffs in tropical deciduous forest, oak woodland, and pine-oak woodland or pine forest.

This species, as defined by Quero (1989), ranges southward in western Mexico to Guatemala. There are large distributional gaps between the Sonoran populations and those of southern Mexico. These gaps, however, could be an artifact of the collection records since this palm tends to grow on cliffs in remote mountain regions with dangerous access due to illicit agriculture.

In riparian canyons along the Río Sátachi, near Nácori Chico, in northeastern Sonora, these palms grow alongside maples (*Acer grandidentatum* Nutt.), oaks (*Quercus* spp.), and organpipe cacti (*Stenocereus thurberi* [Engelm.] Buxbaum). The main palm canyon at Cerro Cinta de Plata (Sierra Baviso, about 25 km southeast of Magdalena de Kino), on the southwest

side of this limestone mountain, supports the largest and densest population of this species in Sonora. Thousands of palms are crowded in the rocky canyon bottom and below north-facing cliffs of this deep, rugged, and steep bowl-shaped box canyon, locally called El Baviso. Cattle are excluded from the canyon by huge boulders and rock faces at its lower end. Smaller populations occur in other nearby canyons and mountains that are likewise inaccessible to cattle. These palms were misidentified by Shreve (1951: 74) as *Sabal uresana* and by Wiggins (1964: 324) as *Erythea roezlii*.

Horticulture.—*Brahea nitida* is readily grown from fresh seed and is occasionally cultivated in southern Arizona in Phoenix and in warmer areas in Tucson. It is the most frost-sensitive of the cultivated Sonoran palms. In Tucson the leaves are often severely damaged by freezing weather, and it probably cannot be grown out-of-doors in the colder areas of the city. This magnificent palm is worthy of extensive cultivation in hot, arid to semiarid climates.

Note.—We are following Quero (1989) in treating *B. prominens* as a synonym of *B. nitida*.

Specimens examined.—MPIO. ALAMOS: 2 km S of Santa Bárbara, pine-oak forest, Jenkins 92-114 (ARIZ). El Terrerito, pine-oak-su-

mac woods, 27°32'30"N, 108°42'30"W, 5400 ft, 18 May 1986, *Martin s.n.* (ARIZ). Waterfall at Sahuarivo, 27°20'N, 108°39.8'W, ca. 1500 m, moist pine-oak woodland, barranca drains to San Bernadino [sic, = Bernardo], 17 Mar 1992, *Martin et al. s.n.* (ARIZ). Ca. 5 mi W of Chinipas on rd from Los Tanques, pine forest, 5 May 1996, *Larson s.n.*—MPIO. CUCURPE: Palm Canyon, 23 km (15–17 mi) SE of Magdalena on road to Cucurpe, SW flank of Cerro Cinta de Plata [Sierra Baviso], 1050± m: *Boutin & Kimmach 3744* (BH); *Estrada et al. 515* (BH); *Felger 3275* (ARIZ); 16 Jul 1977, *Van Devender et al. s.n.* (ARIZ).—MPIO. NÁCORI CHICO: Arroyo Chinalito, Río Sátachi, downstream from Nácori Chico, 2930 ft, *Felger 3307* (ARIZ). Rancho Pinalito, Sierra Torro Muerto, E of Buena Vista, 29°38'N, 108°55.5'W, ca. 1000 m [ranges to 1300 m], *Joyal 2361* (ARIZ).—MPIO. NACÓZARI: [Sierra del Tigre]: Cañón del Temblor, oak-grassland, 23 Aug 1940, *E. A. Phillips 735* (GH); Between Las Tieritas and Cañón de las Gallinas, oak-grassland, 25 Aug 1940, *Phillips 739* (GH). Cañón del Temblor, oak-grassland, 19 Aug 1940, *Phillips 590* (ARIZ, GH).—MPIO. unknown: Las Pinitas, 12 Oct 1890, *Hartman 140*, Lumholtz expedition (GH). Huehuerachi, 7 Dec 1890, *C.E. Lloyd 469*, Lumholtz expedition (GH).

Observation.—MPIO. GUASABAS: Cañón Cruz de Peñasco (E of Guasabas), rock walls of canyon and canyon bottom, Felger, 5 June 1960.

PHOENIX L., Sp. Pl. 1188. 1753.

About 12 species native to the Old World (Barrow 1998).

PHOENIX DACTYLIFERA L., Sp. Pl. 1188. 1753.—TYPE: *Palma hortensis mas et foemina* in Kaempfer, *Amoenitatum Exoticarum* 668, 686, t. 1, 2 (1712); (see *Taxon* 28: 59–70. 1979).

Vernacular names.—*dátil* (in Sonora also used for various species of *Yucca* with indehiscent, fleshy fruits); date palm.

Description.—Large palms branching (suckering) from the base. Leaf bases persistent on the trunk. Leaves glaucous gray-green, several meters long. The genus is “easily distinguished from all other palms by the induplicate [leaflets V-shaped in cross-section] pinnate leaf with the lower leaflets modified as spines” (Uhl and Dransfield 1987: 217). Dioecious; inflorescence branches orange, much shorter than the leaves. Male flowers with very short filaments. Pericarp sweet and edible, the seeds ca. 1.5–3 cm long, more than twice as long as wide, and conspicuously grooved.

Distribution.—A few date palms are marginally naturalized, or perhaps only persistent, on Isla Lobos, a coastal, sand-bar island of southwestern Sonora. Elsewhere date palms occasionally persist from abandoned plantings. In contrast, this palm is naturalized at widely scattered riparian or semiriparian habitats in Baja California Sur.

Horticulture.—The date palm is native to the Middle East, although truly wild populations are not known with certainty to exist. It was apparently first brought to Sonora by the Jesuit missionary Padre Eusebio Kino

in the late seventeenth century. At that time only seeds could be transported. Vegetatively propagated varieties were first successfully introduced into the southwestern United States in 1890 (Nixon 1950) and presumably soon taken to Sonora. Date palms are widely cultivated, sometimes commercially, in the lowlands throughout Sonora. The widely cultivated *P. canariensis* Hort. ex Chabaud is distinguished by its massive, solitary trunk, and green leaves.

SABAL Adanson ex Guers., *Bull. Sci. Soc. Philom. Paris* 87: 205–206. 1804.

Southeastern United States to northern South America including most of Mexico except the Baja California peninsula, most of the Caribbean, and Bermuda; 16 species (Quero 1989; Zona 1990).

SABAL URESANA Trel., *Ann. Rep. Mo. Bot. Gard.* 12: 79, pl. 35–37. 1901. *Inodes uresana* (Trel.) O. F. Cook, *Bull. Torr. Bot. Club* 28: 534. 1901.—TYPE: Mexico, Sonora, in the uplands, a few miles to the N of Ures, 17 Aug 1900, *Trelease 379* (holotype MO!; photo, 25 Oct 1934, BH!). Fig. 8.

Vernacular names.—*Palma* (through much of Sonora). *Palma grande* (Rancho Santa Bárbara, Alamos region). *Palma real* (vicinities of: Alamos; Guajaray, north of Alamos; and Nácori Chico). *Palma del suelo* (juvenile plants, eastern Sonora near Nácori Chico to the vicinity of Alamos). *Palma del taco*, or *taco* (adult plants, throughout the range in Sonora). Indigenous languages: *Sauí*, *sabó*, *ta'cu* (Guarijío). *Ta'aco* (Mayo). *Sajavil* (Mountain Pima; vicinity of Yécora to Maycoba). *Maahagam* (Pima Bajo; Rea 1997). *Zamij ctam* (Seri; Felger and Moser 1985).

Description.—Large palms, often ca. 5–15 m tall, the trunks often 26–36 cm in diameter, commonly fire-scarred. Leaves large, reaching 4.4 m long, the petioles entire, (64–)80–260 cm long, to 9 cm wide near base and 2.5–5 cm wide just below the blade, the hastula 5–18 cm long, triangular, more than twice as long as wide, persistent and firm with entire margins, the blades often ca. 90–180 cm long (from base of hastula to apical tip), markedly costapalmate (the petiole extends well into the blade on the lower or abaxial surface), partly curved, glaucous bluish green, often with coarse intersegmental fibers.

Inflorescences including peduncles 96–235 cm long, spreading to arching (not drooping), much branched, shorter than, to sometimes nearly as long as the leaves. Flowers sessile; sepals united below, the lobes entire, the petals 4.4–5.3 mm long; filaments rather fleshy, united below into a tube about as long as the sepals, the free portion relatively long. Fruits 13–23 mm in diameter, 12–18 mm in height, globose, brown to



Fig. 8. *Sabal uresana*. Northeastern Sonora, Municipio de Nácori Chico, Rancho Napopa. Mesquite-grassland-Sonoran Desert vegetation. Note the costapalmate, curved leaf blades of the immature palm in lower right. Photo by E. J., August 1993.

blackish; seeds 10–16 mm in diameter, 4–10 mm in height, depressed-globose, dark red-brown (“chestnut”) to blackish, glossy. Flowering April to June, mostly in May; fruits ripening in August in the desert, and September and October in the mountains. $2n = 36$ (Eichhorn 1957).

Distribution.—Sonoran desertscrub, thornscrub, tropical deciduous forest, and lower elevations in oak woodland. West-central and eastern Sonora, from near sea level–1220 m. Mostly on deep, gravelly to sandy or silty soils. Scattered groves along or near the coast from Bahía San Carlos northward to Bahía San Pedro, mostly along the bottom of riparian canyons including Nacapule and Barajitas, low-lying swales or depressions, and occasionally on coastal dunes and upper beaches. Farther inland on sandy plains, *bajíos* (low-lying areas), hills, floodplains, and canyon bottoms. On low hills in eastern and central Sonora from Opo-depe southward, especially near the desert-thornscrub ecotone (Fig. 8). Seldom on rocky slopes. *Sabal* palms are often left standing in fields, orchards, and pastures.

This species also occurs in southwestern Chihuahua where it is probably not rare. We do not know of any specimens, however. The one record (Zona 1990) is a herbarium sheet at BH with correspondence from

George Lindsay but lacks a specimen. We have seen no specimens from Sinaloa, but a large palm extensively utilized for making hats in the vicinity of Choix in northeastern Sinaloa appears to be this species (Barney Burns, pers. com., 1995). Furthermore, Hermilo Quero (pers. comm., 1998) reports that he has documented it from northern Sinaloa.

There seems to be north-south and elevational clinal variation in overall plant size with plants of the northern populations larger than those to the south. There is also geographic variation in fruit size, with the northernmost populations bearing the largest fruits, while plants near Ures and along the coast bear the smallest fruits.

Horticulture.—Occasionally cultivated in Sonora and Arizona, *S. uresana* is recommended as a landscape tree for large areas. It is not damaged by freezing temperatures at least as far north as Tucson. The plants seldom survive bare-root transplanting and are not suited to container cultivation since they quickly develop deep roots.

Notes and comments.—Bruchid beetle larvae in the genus *Caryobruchus* (Bruchidae: Pachymerinae) feed on *Sabal* seeds, and adults feed on the floral nectar.

Seed predation by bruchids can be as high as 50–90% (Zona 1990; Joyal 1995). The fruits also are eaten by many animals including coatis, coyotes, foxes, raccoons, and ringtail cats. Hooded and streaked-backed orioles weave their nests from the leaf fibers, attaching them to the undersides of leaf blades.

The plants and fruits of *S. uresana* are among the largest of any species of the genus. Southward in Sinaloa this species is replaced by *S. rosei* (Cook) Becc., distinguished in part by its more slender trunks and greener leaves. *Sabal rosei* in turn is replaced by *S. pumos* (Kunth) Burret farther south in the Río Balsas Basin. These three sabals constitute the phylogenetic arm of the genus in western Mexico (Zona 1990). There is a gap of approximately 300 km between the southernmost documented *S. uresana* and the northernmost *S. rosei*. However, this intervening area is poorly known botanically and much of it was converted to agriculture long ago.

Specimens examined.—MPIO. ALAMOS: 1 km downstream from Sabino (NE of Alamos) along the Río Cuchujaqui, in riverbed, not common, 22 Jan 1961, *Felger 5026* (ARIZ). Alcorn's ranch at San Pedro, 27°03'N, 108°42.2'W, 8 Oct 1994, *Jenkins 94-136* (ARIZ). Las Cabras, ESE of Alamos, 27°00'N, 108°55'W, 340–360 m, *Joyal 1328*, *Joyal 1497* (ARIZ). Rancho Santa Bárbara, E of Alamos, 27°05.5'N, 108°42.5'W, 750–800 m, *Joyal et al. 1442* (ARIZ). Rancho San Pedro, 27°03'N, 108°42'N, 450 m, 9 Nov 1988, *Martin s.n.* (ARIZ). Near Sabinito Sur, 20 Dec 1989, *Martin s.n.* (ARIZ).—MPIO. GUAYMAS: Nacapule Canyon, *Bailey 26* (BH). Los Anegados, north of Bahía San Carlos, *Felger 3096* (ARIZ). Palmar, at Rancho Palmar, NW of Bahía San Carlos, *Felger 3100* (ARIZ). La Huerta, *Felger 3070* (ARIZ). Back of San Carlos Bay, 27 Mar 1934, *Bailey 1* (BH). San Carlos Bay, ranch and palm grove in broad flood plain just inland from S[an] C[arlos] B[ay] Motel, 3 m elev., *Boutin 2010* (BH). San Carlos Bay, *Johnston 4345* (CAS, UC, US). San Carlos Bay, Dec 1960, *Schnabel s.n.* (BH, photo). N of San Carlos Bay and Tetas Cove, 10 m elev., *Boutin 2013* (BH). Ensenada Grande [= Bahía San Pedro], Feb–Mar 1947, *Lindsay s.n.* (BH). San Pedro Bay, *Moran 4037* (BH).—MPIO. HERMOSILLO: Cultivated in plaza principal, coll. in vicinity of Hermosillo, *Rose et al. 12518* (US).—MPIO. MOCTEZUMA: 20.6 mi E of Mazocahui on road to Moctezuma, ca. 2900 ft, *Felger 3347* (ARIZ). Km 128 W of Moctezuma on Hwy 14 to Mazocahui, 29°35'–40'N, 109°55'–60'W, <1000 m, *Joyal 2044* (ARIZ).—MPIO. NÁCORI CHICO: 3.8 mi by road NW of Nácori Chico, valley bottom, *Felger 3306* (ARIZ). Rancho Los Pescados, ca. 20 air km SSW of Nácori Chico, 29°29'N, 108°59'W, ca. 780 m, *Joyal & Silva 1727* (ARIZ). Rancho La Ciénega Arriba, 29°37'–38'N, 109°04'W, 980 m, *Joyal 2033* (ARIZ). Rancho Napopa, S of Buena Vista, 29°29'N, 108°54'W, 900–1000 m, *Joyal & Silva 2316* (ARIZ).—MPIO. QUIRIGEO: El Ranchito, 3 km N of Los Bajíos, 27°42'N, 108°59'W, 450–500 m, *Joyal et al. 2417* (ARIZ).—MPIO. ROSARIO TESOPACO: San Martín, between Nuri and Rosario, 27°55'N, 109°19'–20'W, 500 m, *Joyal 2495* (ARIZ). El Sauz, 8 km NNW of Rosario Tesopaco, 27°55'N, 109°22'–23'W, 440–460 m, *Joyal 2496* (ARIZ). 6 mi S of Cedros, *Wiggins 6433* (DS, US).—MPIO. TEPACHE: 7.7 mi by road SW of Tepache, 29.4'N, 109.6'W, 545 m, *Turner et al. 71-53* (BH).—MPIO. ÚRES: 10.8 mi N of Ures on road to Rayón, *Felger 3002* (ARIZ). Rancho La Raja, ca. 15 km S of Ures, 29°16'N, 110°20'W, 450–500 m, *Joyal 2525* (ARIZ). Rancho La Noria Aguilareña, ca. 20 km N of Ures, 29°35'N, 110°23'W, ca. 530 m, *Joyal 2577* (ARIZ).—MPIO. YÉCORA: Rancho Yurbanis, N of Tepoca on San Nicolás-Sahuaripa road, 28°30'–31'N, 109°10'–11'W,

800–900 m, *Joyal 1667* (ARIZ). Los Bajíos, ca. 10 km by air S of Guisamopa, 28°35'N, 109°07'W, ca. 800 m, *Joyal et al. 2478* (ARIZ). Rancho El Palmar de Onavas, on Hwy 16, between Tonichi and Tepoca, 28°29'–30'N, 109°24'W, ca. 700 m, *Joyal 2576* (ARIZ). Rancho Palmar, E of Río Yaqui on Hwy 16, NE of Onavas, *Rea 816* (SD). 20 mi (by road) NE Mazocahui, just past Rancho Rodeo, *Marin M72-23* (SD).

WASHINGTONIA H. Wendl., *Bot. Zeit.* (Berlin) **37**: lxi, 68, 148. 1879 (conserved name).

Two closely related species (Bailey 1936). *Washingtonia filifera*, native to waterholes and riparian canyons in northeastern Baja California (norte), southeastern California, and western Arizona, and naturalized or adventive in southern Nevada (Turner et al. 1995). It is distinguished in part from *W. robusta* by its conspicuously thicker trunk (especially in cultivation) and dull green leaves.

WASHINGTONIA ROBUSTA H. Wendl., *Gart.-Zeitung* (Berlin) **2**: 198. 1883. *Neowashingtonia robusta* Heller, Cat. N. Amer. Pl. 3. 1898.—TYPE: Illus., André, Revue Horticole. 404, Fig. 73. 1885.

Washingtonia sonora S. Watson, *Proc. Amer. Acad. Arts* **24**: 79. 1890. *W. filifera* var. *sonora* (S. Watson) M. E. Jones, *Contr. W. Bot.* **15**: 48. 1929. *Neowashingtonia sonora* (S. Watson) Rose, *Contr. U.S. Natl. Herb.* **5**: 255. 1899.—TYPE: Mexico, Sonora, in secluded cañon[e]s in the mountains about Guaymas, Oct. 1887, Palmer 311 (holotype GH!; isotype CAS!). *Washingtonia gracilis* Parish, *Bot. Gaz.* **44**: 420, figs. 8–10, 1907. *W. robusta* var. *gracilis* Parish ex Becc. *Webbia*, **ii**, 197. 1907. “Described from cultivated trees grown in San Bernardino and Riverside, California, probably native to Lower California.”

Vernacular names.—*Abanico* (‘fan,’ referring to fan palm, term in Sonora for cultivated plants). Mexican fan palm (Arizona, for cultivated plants). *Zamij ctam* (Seri; Felger and Moser 1985).

Description.—Trunks reaching ca. 15–20 m tall, 98–104 cm circumference, often fire-scarred. Petioles of juvenile to half-grown trees armed with strong, sharp, orange-brown teeth 10–15 mm long along the full length, some teeth double-pointed; petioles of taller trees often reaching 1.4 m long, the margins entire or with some basal teeth to 3.0–3.5 mm long. Hastula large, papery, more or less triangular, the margins irregular, fraying with age; leaf blades uniformly shiny green on both surfaces, nearly flat, the free portion of the segments usually drooping.

Flowering branches often reaching ca. 2.6 m long, longer than the leaves, arching, then drooping with weight of the fruits. Flowers white, short-pedicelled; sepals united below, the lobes with ragged margins; stamens separate, borne on the corolla tube. Flowering May and June, the fruits ripening in fall to early spring. Fruits ellipsoid, 7.5–9.0 mm long, blackish

when ripe, the thin, fleshy pericarp edible and sweet like a date, the fruits mostly falling with the dry, persistent calyx and short pedicel. Seeds 4.7–6.5 mm long, 4.5–4.9 mm wide, ellipsoid to globose, dark red-brown, smooth or nearly so on the dorsal side, the lower surface (hilum side) wrinkled. $2n = 36$ (Eichhorn 1957).

Distribution.—In Sonora native only to canyons and oases in the Sierra El Aguaje at ca. (10–) 30–135 m. Locally dense populations occur in the upper part of Cañón del Nacapule and in several very steep, seaward-facing canyons and oases in mountains along the coast northwest of Bahía San Carlos, e.g., La Huerta. Also locally abundant along canyon bottoms and oases in the canyon systems of Los Anegados and Las Barajitas. In all of these canyons and oases seedlings and small plants are abundant. These palms are limited to immediate margins of streams and at springs with permanent or near permanent water or wet soil where it locally outnumbers *Brahea* and *Sabal*.

The limited distribution and extremely localized groves of *W. robusta* in Sonora make it vulnerable to local extirpation. Rose (1899: 255) found *W. robusta* at Guaymas, and reported that “most of them have been cut out and used as rafters for houses.” Later reports make no mention of this species occurring naturally at Guaymas. This species is otherwise native only in Baja California Sur.

Palms on the western slopes of the Sierra del Tigre reported as *W. sonorae* by White (1948, Fig. 21) are actually *Brahea*, probably *B. elegans*.

Horticulture.—Although of very local and limited distribution in its native habitats, together with the date palm it is one of the most widely cultivated extra-tropical palms in the world. This tall, stately palm is a common street tree and landscape subject in northwestern Mexico, southern Arizona, and southern California. It is the fastest-growing of the Sonoran palms. This species is raised in containers or field-grown and commonly transplanted even when large.

Both species of *Washingtonia* thrive best in dry or seasonally dry climates with some cool winter nights. *Washingtonia filifera* is much more frost-tolerant than *W. robusta* (see Turner et al. 1995). In cultivation *W. robusta* grows well with hot and either dry or humid summer climates, whereas *W. filifera* is susceptible to lethal bud rot when cultivated in regions with a summer rainy season or wet, foggy climates such as coastal California (Bailey 1936).

Notes.—The fruits are eagerly eaten by many birds and various mammals including badgers, coyotes, and raccoons. Seeds are often found germinating in decaying raccoon droppings. Bailey (1936) pointed out that petioles of mature trees have few or no marginal

spines. Cornett's (1986) note on *W. filifera* confirms Bailey's earlier observations and speculates that there might have been a relationship with Pleistocene mastodons which had a vertical reach of about 6 m. However, *Sabal* has entire petioles throughout its life history, and certain *Brahea* species retain stout petiole spines throughout their lifespan.

Specimens examined.—MPIO. GUAYMAS: Cañón del Nacapule: Bailey 3, and 262 (BH); Felger 3118 (ARIZ). Los Anegados, Felger 3095 (ARIZ). La Huerta, Felger 3068 (ARIZ). Pirinola Canyon, Bailey 16 (BH).

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