

NOMENCLATURE OF *IPOMOEA ARBORESCENS* (CONVOLVULACEAE) IN SONORA, MEXICO

Daniel F. Austin

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

Richard Felger

Drylands Institute
PMB 405, 2509 N. Campbell Avenue
Tucson, Arizona 85719, U.S.A.

Thomas R. Van Devender

Arizona-Sonora Desert Museum
2021 N. Kinney Road
Tucson, Arizona 85743, U.S.A.

ABSTRACT

Ipomoea arborescens (tree morning glory) has two varieties in the state of Sonora, Mexico. Author citation of *I. arborescens* var. *glabrata* (a nomenclatural synonym of *I. arborescens* var. *arborescens*) is corrected. The second taxon, *I. arborescens* var. *pachylutea*, was named by Howard Scott Gentry from the Río Mayo region. These plants differ considerably from *I. arborescens* var. *arborescens* in having different bark morphology and corolla tube colors.

RESUMEN

En el estado de Sonora, México, *Ipomoea arborescens* (palo santo) tiene nombres para dos variedades. Se corrige la citación del autor de *Ipomoea arborescens* var. *glabrata*, sinónimo de *Ipomoea arborescens* var. *arborescens*. Howard Scott Gentry nombró *I. arborescens* var. *pachylutea* de la región del Río Mayo, la cual se distingue principalmente de la var. *arborescens* por su corteza amarillenta y corolas con tubos morados.

During studies of the Convolvulaceae for both the *Flora Mesoamericana* (Austin et al. in prep.), and the *Trees of Sonora, Mexico* (Felger et al. 2001), it became apparent that there is nomenclatural confusion with plants called *Ipomoea arborescens*. In addition, there is biological uncertainty about the taxonomic delimitations of these Mexican trees. This paper will address the nomenclatural problems.

When Gentry (1942) was studying the plants of the Río Mayo region of southern Sonora, he encountered two different varieties of this tree. One of these he called *I. arborescens* var. *glabrata*, and the other he named *I. arborescens* var. *pachylutea*. Although the most recent revision of the group by McPherson (1981) does not mention either variety, subsequent field studies by various botanists (e.g., Martin et al. 1998; Van Devender et al. 2000; Felger et al. 2001) make it clear that in Sonora there are indeed two distinct morphotypes subsumed by the binomial *I. arborescens*. There is as well a third morphotype farther south for which we have insufficient data to completely compare with Sonoran plants.

The species is widespread and may be characterized by the following:

Ipomoea arborescens (Humb. & Bonpl. ex Willd.) G. Don, Gen. Syst. 4:267. 1838.

Convolvulus arborescens Willd., Enum. Pl. 1:204. 1809. TYPE: MÉXICO. GUERRERO: between Acaguisotla and Chilpancingo, *Humboldt & Bonpland* 3927 (HOLOTYPE: P; microfiche seen).

Trees 5–15 m tall; the trunk thick, often 50–70 cm diameter, the bark gray, whitish or pale yellowish, stems with abundant latex, tomentose when young with trichomes 0.1–2.5 mm long, glabrescent. **Leaves** 9–27 cm long, 6–9+ cm wide, ovate to lanceolate, glabrescent, the apex acuminate, the base cordate, with trichomes longer than those on the branches, velvety at least below, the midrib base (just above the petiole) with a pair of blisterlike glands 1–3 mm in diam., turgid on young, enlarging leaves (these glands are the same color as the midrib and may be difficult to see, especially on older or dried specimens). **Inflorescences** terminal or axillary, monochasial, racemose. **Flowers** 1(–2); sepals 6–14 mm long, ovate to rarely orbicular, more or less equal, tomentose, the apex obtuse to obtuse-mucronate; corollas 4–4.3 cm long, often 6.5–9.5 cm wide, funnel-form, tomentose at least on the lobes, white, tube green without. Fruits 17–25 mm long, capsular, 4-valvate, brown, glabrous; seeds 1–4, 9–16 mm long, brown, pilose on the margins with trichomes 10–15 mm long.

Illustrations.—Martínez (1969: 237), Felger et al. (2001: 139–141).

Common names.—Tree morning glory; *cazahuate* (from Distrito Federal to Oaxaca), *jútuguo* (Mayo, southern Sonora), *osí* (Tarahumara, Chihuahua), *palo blanco* (Sonora), *palo santo* (Sonora), *patancán blanco* and *rosí* (Durango, Jalisco, Michoacán, Guerrero), *tochiyó* (Guarijío, SE Sonora).

Flowering November–April; near sea level–1800 m; Sonoran desertscrub, thornscrub, tropical deciduous forest, and oak woodland or rarely at the lower edge of “tropical” pine-oak forest (Fig. 1).

The type locality is between Acapulco and Cd. México, in a mid-elevation seasonally dry tropical zone. The original vegetation at the type locality was probably tropical deciduous forest. That region is the southern part of the “typical” habitat of the modern known range of *I. arborescens*, although the species ranges into the highlands of Edo. México, Michoacán, and Morelos.

Gentry (1942) called the “smaller, less pubescent-leaved form characteristic of the species throughout the foothill regions of southern and central Sonora” var. *glabrata*. The trees that extend into the Sonoran Desert North of Hermosillo are probably the same taxon as Gentry’s variety *glabrata*. Trees of the lowland and northern Sonora populations have conspicuously lighter-colored (whiter) bark, and flowers with the purple coloration much reduced or lacking when compared with var. *pachylutea*.

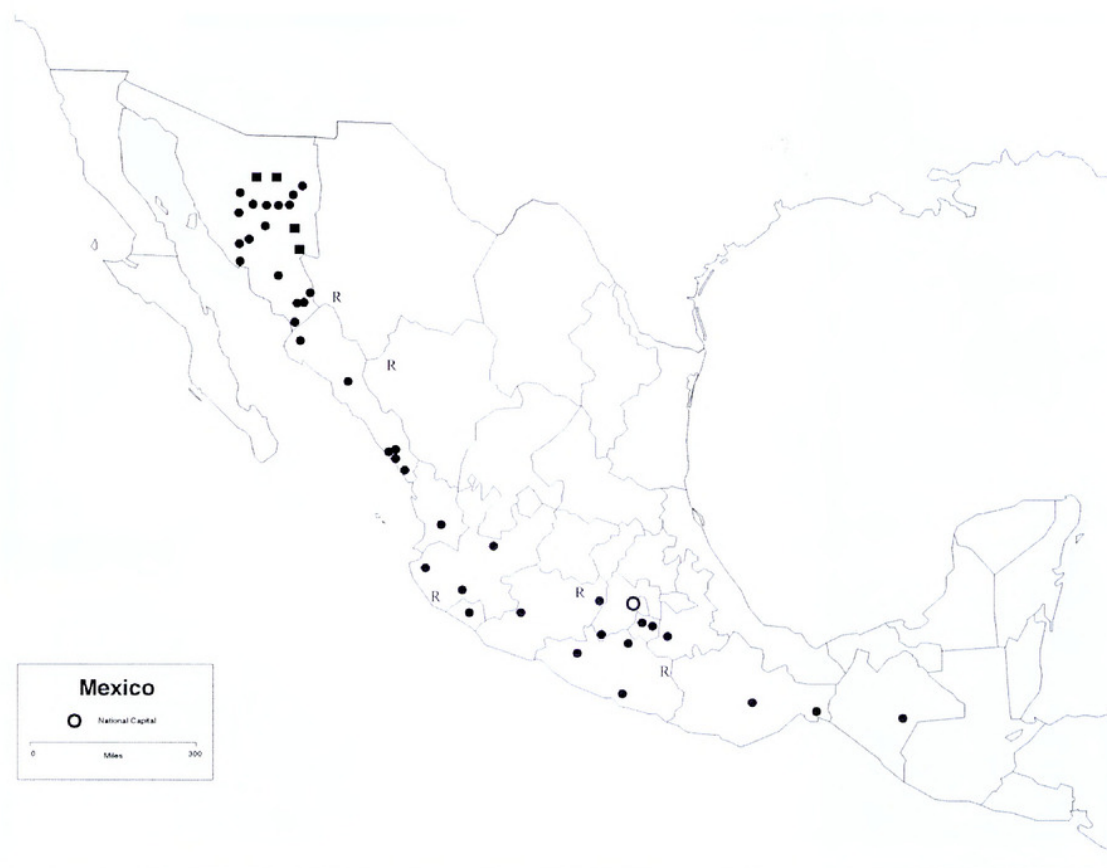


FIG. 1. Distribution of *Ipomoea arborescens* in Mexico. **Dots** = herbarium specimens; **squares** = sight records reported by Turner et al. 1995; **R** = report by Torres-R. (2004). Based on Rose (1894), Matuda (1963, 1966), McPherson (1981), Cowan (1983), Torres-R. (2004), and herbarium specimens at MEXU, MO, and ARIZ.

KEY TO SYNOPTIC TRAITS

Habitat Sonoran desert-scrub to tropical deciduous forest and lower oak woodland.

Bark white. Flowers white with yellow or diffuse pale purple dots and short bands within the tube (Figs. 2, 3). Flowers in Sonora visited by bees, hawkmoths, and hummingbirds, south of Sonora by bats _____ *Ipomoea arborescens* var. **arborescens**

Habitat humid tropical deciduous forest and oak woodland. Bark yellowish. Flowers

solid or almost solid dark-purplish within the tube. Flower visitors unknown _____ *Ipomoea arborescens* var. **pachylutea**

NOMENCLATURE

Ipomoea arborescens (Humb & Bonpl. ex Willd.) G. Don var. **arborescens**. *Ipomoea arborescens* (Humb & Bonpl. ex Willd.) G. Don var. *glabrata* Gentry, Carnegie Inst. Wash. Publ. 527:212. 1942. TYPE: MÉXICO. SONORA: Arroyo Cuchijaqui, Gentry 870 (SYNTYPE: DS, n.v., cited by McPherson); San Bernardo, Gentry 1158 (LECTOTYPE, here chosen: ARIZ!; ISOLECTOTYPE: MO!).

Ipomoea murucoides var. *glabrata* Rose, Contr. U.S. Natl. Herb. 1:107. 1891, non A. Gray (1887). TYPE: MÉXICO. SONORA: Alamos, Palmer 316 (HOLOTYPE: US!).



FIG. 2. Corollas of *Ipomoea arborescens* var. *arborescens* as they are in plants in Sonora. The small and spotted areas of purple in the corolla throats are distinctive.



FIG. 3. Corollas of *Ipomoea arborescens* var. *pachylutea* in Sonora. The large and almost continuous areas of purple in the corolla throats are distinctive.

When Gentry made this combination, he cited the correct protologue by Rose, but incorrectly listed Gray as the author. Since the varietal name by Rose was a later homonym of var. *glabrata* A. Gray, we are interpreting Gentry's action as creation of a new name (Article 58). Tentatively, we consider this a nomenclatural synonym of *I. arborescens*. McPherson (1981) also considered the glabrous forms of the plants as a synonym, because he cited the type of *I. murucoides* var. *glabrata* Rose in synonymy with *I. arborescens*. As pointed out by Gentry (1942), there are differences between these northern plants and those farther south, but we do not have enough data on the southern populations to determine if the two should be considered nomenclaturally distinct.

These are the plants that Soderholm and Gaskins (1963) called *I. wolcottiana*. The USDA collection forming the basis of their report grows in Miami at both the Plant Introduction Station and the Fairchild Tropical Garden and its identity has been verified as *I. arborescens* var. *glabrata*. Presumably that report is also the basis of the incorrect report of *I. wolcottiana* from Sonora. That species has not been documented in Sonora.

Ipomoea arborescens (Humb & Bonpl. ex Willd.) G. Don var. ***pachylutea*** Gentry, Carnegie Inst. Wash. Publ. 527:213. 1942. TYPE: MÉXICO. SONORA: Sierra de Alamos, Gentry 3000 (LECTOTYPE: ARIZ!; ISOTYPES: MO!, UC, n.v., US!). PARATYPE: MÉXICO. SONORA: Algodones, Sierra Charuco, Gentry 2299 (ARIZ!).

Selected additional specimens seen: Sonora, Sierra de Alamos, rocky slopes and canyon bottoms, 2000–3000 ft [610–915 m]. Vernacular: *palo santo amarillo*. Large trees with massive trunks & yellowish bark browning with age; 8–15 m high. Petioles and twigs with milky juice, Gentry 4888 (ARIZ); Sinaloa, Las Mesas, Sierra Surotato, 25 Aug 1941. Oak-*Ipomoea* savanna; volcanic ash, elev. ca. 3000 ft [915 m]. Vernacular: *palo blanco*. Tree with yellow bark. Co-dominant with oak. Gentry 6144 (ARIZ). Additional specimens were cited by Martin et al. (1998), McPherson (1981), and Turner et al. (1995) mapped the species.

Common name.—*Palo santo amarillo*.

Gentry (1942) named the higher elevation or montane populations in southeastern Sonora and adjacent southwestern Chihuahua var. *pachylutea*, and distinguished these trees from *I. arborescens* var. *glabrata* in having “...yellowish bark, larger and more pubescent leaves, longer and stouter pedicels, larger and more numerous flowers, larger sepals, and generally heavier inflorescences.” Other differences include wood that is apparently not as soft, corollas with a prominently maroon-purple throat, and pale lavender filaments. *Ipomoea arborescens* var. *pachylutea* occurs at ca. 500–1220 m in tropical deciduous forest and the lower oak zones. To date, variety *pachylutea* is known only from Sonora and Chihuahua, but no comparison has been made with living plants farther south.

The southern limits of var. *pachylutea* remain unknown. Both varieties occur in southeastern Sonora, but do not occur intermixed with minor exceptions. Near Alamos, Sonora, a single tree of var. *pachylutea* was found in an area

of var. *arborescens* trees. Such trees, however, are in disturbed, partially cleared areas at elevations near the usual lower elevational limits of var. *pachylutea*. Trees of intermediate character are not known, and the varieties abruptly replace each other. We suspect that the two “varieties” are actually cryptic species.

Grown side-by-side at the Arizona-Sonora Desert Museum in Tucson from seed collected in Sonora, plants of var. *pachylutea* bear leaves nearly twice as large as those of var. *arborescens* (var. *glabrata* sensu Gentry 1942). In the field, Sonoran populations of these varieties exhibit overlap in leaf sizes. In Arizona plantings, variety *pachylutea* tends to branch near the base of the plant with large horizontal branches, while living specimens of var. *arborescens* generally do not share these features and develop a thick trunk at an earlier age. However, in dense forests near Alamos, *Ipomoea arborescens* var. *pachylutea* is an upright tree.

One of the difficulties in applying these names to herbarium specimens is that there typically are few obvious traits retained that can be used in distinguishing the two taxa, even though living trees are quite distinctive. When flowers are present, dissection of the corollas will reveal the needed ‘comparative’ differences in purple within the base of the tube. Even when both forms are not available, the two may be separated relatively easily. The inside of the tube of var. *pachylutea* is solid or nearly solid purple throughout; tubes of var. *arborescens* are variable but usually lighter in color—diffusely colored with bands and dots of light purple. Beyond that trait, we have found no consistent herbarium differences in the sizes of leaves or flowers that Gentry noted, as there is considerable variation throughout the range of the species.

Although no field phenology data are available for Sonora, trees grown in Tucson flower at different times. Data taken over 10 seasons on var. *arborescens* indicate that its beginning flowering dates vary from the third week in October to the third week in January. However, the trees cease flowering before the third week in February. By contrast, two season’s data show that var. *pachylutea* does not begin flowering until the second week in March. Thus, a full two weeks separate the flowering periods. Based on herbarium specimens at ARIZ, these differences do not hold for wild plants in Sonora where flowering seasons of both varieties overlap.

The floral biology is variable and is largely temperature-dependent (Alberto Búrquez M., pers. comm. 1998; Francisco Molina F., pers. comm. 2001). The flowers commonly open in the late afternoon. During warmer weather, the corollas fall the next morning with warming daytime temperatures, but on cooler days they often do not fall until the second night. This is consistent with a number of matinal and/or nocturnal species in the family (Austin, unpubl. data). The trees are self-incompatible (Alberto Búrquez M., pers. comm. 1998); buds attract both red and black large ants (Felger et al. 2001), perhaps *Camponotus*.

In Sonora, *Hyles lineata* (white-lined sphinx moth) and perhaps other

hawkmoths and hummingbirds are the primary pollinators of var. *arborescens* (Felger et al. 2001). The flowers are visited by hummingbirds in tropical deciduous forest and foothills thornscrub from the Alamos area north to Santa Ana de Yécora and Tepoca, and northwest to the Hermosillo area in the Plains of Sonora subdivision of the Sonoran Desert (Van Devender et al. 2004). *Cynanthus latirostris* (broad-billed hummingbird) and *Calypte costae* (Costa's hummingbird) are the most common visitors to *I. arborescens* while *Calpyte anna* (Anna's hummingbird) are sporadically seen. Other avian visitors such as montane species that come down from the pine-oak forest and oak woodland of the Sierra Madre Occidental into the tropical deciduous forest for the winter, include *Amazilia beryllina* (berylline hummingbird), *Heliomaster constantii* (plain-capped starthroat), and *Hylocharis leucotis* (white-eared hummingbird). Bees also visit the plants near Hermosillo (Francisco Molina, pers. comm., 2004).

While agaves (*Agave* spp.), ceibas (*Ceiba grandiflora*), yuccas (*Yucca* spp.), saguaros (*Carnegiea gigantea*), organ pipe cactus (*Stenocereus thurberi*), cardón (*Pachycereus pringlei*), and other cacti are famous for being pollinated by bats (Arizaga et al. 2000; Casas et al. 1999; Fleming et al. 1998; Nassar et al. 1997; Quesada et al. 2003; Stoner et al. 2003; Valiente-B. et al. 1997), these flying mammals do not visit only these plants exclusively. Indeed, flowers on tree *Ipomoea* may supply nectar during the season when few other bat-pollinated plants are in bloom (Hevly 1979; Turner et al. 1995).

Pollinators of *Ipomoea arborescens* var. *pachylutea* are not known, although the white limb and lavender throat may suggest bat-pollination, but bats have not been seen visiting the flowers of *I. arborescens* in Sonora. Farther south in Guerrero, México (Baker et al. 1977; Butanda C. et al. 1978), *I. arborescens* and some other species of tree morning glory are visited and presumably pollinated by *Choeronycteris mexicana* (Mexican long-tongued bat), *Glossophaga soricina* (long-tongued bat; Villa R. 1966), and *Leptonycteris curasoae* (lesser long-nosed bat). Although *L. curasoae* is reported feeding from '*I. arborescens*' in Hidalgo (Baker et al. 1977), that species does not occur there (Carranza-G. et al. 1998); instead the plants probably are *I. rzedowskii*, although *I. murucoides* also grows there. *Leptonycteris curasoae* is known to consume *Ipomoea* pollen in Sonora (Hevly 1979) and *I. arborescens* is one of the few species of *Ipomoea* sturdy enough for bats in the state.

Because the mammals migrate north from central and southern Mexico to southern Arizona and back south during different seasons (Moreno-Valdez et al. 2000; Newton et al. 2003; Wilkinson et al. 1996), a variety of food sources are critical for their survival and reproduction. It is noteworthy that the flowering seasons of the two varieties of *I. arborescens* are different in the Arizona-grown plants because they correspond with the migration dates of the bats. *Leptonycteris* arrives in Organ Pipe Cactus National Monument in April and

May (Hoffmeister 1986; K. Krebs & T. Tibbitts pers. comm., Sep 2004) just after var. *pachylutea* has flowered in Sonora. Adult female *Leptonycteris* have left Arizona by late September, and the juveniles leave later (K. Krebs pers. comm., Sep 2004). *Ipomoea arborescens* var. *arborescens* in Sonora is in flower from October through the end of the year. Therefore, when the bats leave Arizona and fly through northern Sonora, the tree *Ipomoea* are not in flower.

However, in about the southern half of Sonora, there are at least a few animals present during the winter. Francisco Molina (pers. comm., 2004) informed us that "we have captured *Leptonycteris* in Hermosillo (Centro Ecológico) in mid-February visiting Agaves. We have also captured *Leptonycteris* in February at Rancho San Francisco (between San Jose de Pimas and Tecoripa) visiting etchos [*Pachycereus pecten-aboriginum*]." These winter resident *Leptonycteris* apparently are not present much north of Hermosillo (K. Krebs, pers. comm. 2004); hence they are absent from most of the October to January flowering period of *I. arborescens* var. *arborescens*. On the other hand, *Choeronycteris* is present throughout the year in northern Sonora.

Much less is known about *Choeronycteris* because it is not a colonial species gathering in maternity colonies like *Leptonycteris* (Hoffmeister 1986; K. Krebs, pers. comm., Sep 2004). Some individuals remain in Arizona and northern Sonora throughout the winter (K. Krebs, pers. comm., Nov 2004), although it appears that the majority migrate southward. Their young are born in late June (Hoffmeister 1986), and presumably the migrants arrive from Mexico near the same time as *Leptonycteris*. Thus, bats may utilize *I. arborescens* on their migration north through Sonora, but do not appear to do so when going south.

ACKNOWLEDGMENTS

We thank Alberto Búrquez M., Karen Krebs, Ana Lilia Reina-G., Curtis McCasland, Rodrigo A. Medellín, Francisco Molina F., Guillermina Murguía S., Yar Petryszyn, Tim Tibbitts, and Michael F. Wilson for information and aid in examining these plants, herbarium material, and photographs. RSF thanks the Wallace Research Foundation for support. Ana Lilia Reina G. kindly provided the Spanish abstract. Andrew McDonald and an anonymous reviewer provided helpful comments on an earlier draft of the manuscript.

REFERENCES

- ARIZAGA, S., E. EZCURRA, E. PETERS, F.R. DE ARELLANO, and E. VEGA. 2000. Pollination ecology of *Agave macroacantha* (Agavaceae) in a Mexican tropical desert. II. The role of pollinators. *Amer. J. Bot.* 87:1011–1017.
- AUSTIN, D.F., J.A. McDONALD, and G. MURGUIA-S. (in prep.). Convolvulaceae In: *Flora Mesoamericana*.
- BAKER, R.J., J. KNOX JONES, JR., and D.C. CARTER (eds.). 1977. *Biology of bats of the New World family Phyllostomatidae, Part II*. Texas Tech Press, Lubbock.

- BUTANDA-C., A., C. VÁSQUEZ-Y., and L. TREJO. 1978. La polinización quiropterófila: una revisión bibliográfica. *Biotica* 3:29–35.
- CARRANZA-G., E., S. ZAMUDIO-R., and G. MURGUÍA-S. 1998. Una especie nueva de *Ipomoea* (Convolvulaceae), de los Estados de Guanajuato, Hidalgo y Querétaro, México. *Acta Bot. Mex.* 45:31–42.
- CASAS, A., A. VALIENTE-BANUET, A. ROJAS-MARTÍNEZ, and P. DAVILA. 1999. Reproductive biology and the process of domestication of the columnar cactus *Stenocereus stellatus* in central Mexico. *Amer. J. Bot.* 86:534–542.
- COWAN, C.P. 1983. Listados florísticos de México. I. Flora de Tabasco. Instituto de Biología, Universidad Nacional Autónoma de México, D.F.
- FELGER, R.S., M.B. JOHNSON, and M.F. WILSON. 2001. *Trees of Sonora, Mexico*. Oxford University Press, New York, NY.
- FLEMING, T.H., S. MAURICE, and J.L. HAMRICK. 1998. Geographic variation in the breeding system and the evolutionary stability of trioecy in *Pachycereus pringlei* (Cactaceae). *Evol. Ecol.* 12:279–289.
- GENTRY, H.S. 1942. Río Mayo plants. A study of the flora and vegetation of the Valley of the Río Mayo, Sonora. Carnegie Inst. Wash. Publ. 527, Washington, DC.
- HEVLY, R.H. 1979. Dietary habits of two nectar and pollen feeding bats in southern Arizona and northern Mexico. *J. Arizona-Nevada Acad. Sci.* 14:13–18.
- HOFFMEISTER, D.F. 1986. *Mammals of Arizona*. University of Arizona Press and Arizona Game and Fish Department, Tucson.
- MARTIN, P.S., D. YETMAN, M. FISHBEIN, P. JENKINS, T.R. VAN DEVENDER, and R.K. WILSON (eds.). 1998. *Gentry's Río Mayo Plants. The tropical deciduous forest & environs of northwest México*. University of Arizona Press, Tucson.
- MARTÍNEZ, M. 1969. *Las plantas medicinales de México*. Ediciones Botas, México.
- MATUDA, E. 1963. El género *Ipomoea* en México (I). *Anal. Inst. Biol. Univ. Nac. Méx.* 34(1–2): 85–145.
- MATUDA, E. 1966. *Las Convolvulaceas del Estado de México*. Gobierno del Estado de México, Dirección de Agricultura y Ganadería, Toluca, México.
- MCPHERSON, G. 1981. Studies in *Ipomoea* (Convolvulaceae) I. The *Arborescens* group. *Ann. Missouri Bot. Gard.* 68:527–545.
- MORENO-VALDEZ, A., W.E. GRANT, and R.L. HONEYCUTT. 2000. A simulation model of Mexican long-nosed bat (*Leptonycteris nivalis*) migration. *Ecol. Modelling* 134:117–127.
- NASSAR, J.M., N. RAMÍREZ, and O. LINARES. 1997. Comparative pollination biology of Venezuelan columnar cacti and the role of nectar-feeding bats in their sexual reproduction. *Amer. J. Bot.* 84:918–927.
- NEWTON, L.R., J.M. NASSAR, and T.H. FLEMING. 2003. Genetic population structure and mobility of two nectar-feeding bats from Venezuelan deserts: inferences from mitochondrial DNA. *Molec. Ecol.* 12:3191–3198.
- PARRA-TABLA, V. 2002. *Ipomoea wolcottiana* Rose (Convolvulaceae). Ozote. In: F.A. Noguera, J.H. Vega Rivera, A.N. García Aldrete, and Q. Avendaño. *Historia Natural de chamela*. Universidad Nacional Autónoma de México, D.F., México. Pp. 159–161.

- QUESADA, M., K.E. STONER, V. ROSAS-GUERRERO, C. PALACIOS-GUEVARA, and J.A. LOBO. 2003. Effects of habitat disruption on the activity of nectarivorous bats (Chiroptera: Phyllostomidae) in a dry tropical forest: implications for the reproductive success of the neotropical tree *Ceiba grandiflora*. *Oecologia* 135:400–406.
- ROSE, J.N. 1894. Some notes on the tree Ipomoeas of Mexico. *Gard. and Forest* 7:364–367.
- SODERHOLM, P.K. and M.H. GASKINS. 1963. *Ipomoea wolcottiana*, a tree morningglory. *Amer. Hort. Mag.* 42:111–113.
- STONER, K.E., K.A.O. SALAZAR, R.C. FERNÁNDEZ, and M. QUESADA. 2003. Population dynamics, reproduction, and diet of the lesser long-nosed bat (*Leptonycteris curasoae*) in Jalisco, Mexico: implications for conservation. *Biodivers. & Conservation* 12:357–373.
- TORRES ROJO, J.M. 2004. Especies con usos no maderables en bosques tropicales y subtropicales en los estados de Durango, Chihuahua, Jalisco, Michoacán, Guerrero y Oaxaca. URL: http://148.233.168.204/pfnm2/fichas/ipomoea_arborescens.htm.
- TURNER, R.M., J.E. BOWERS, and T.L. BURGESS. 1995. Sonoran Desert plants. An ecological atlas. University of Arizona Press, Tucson.
- VALIENTE-BANUET, A., A. ROJAS-MARTÍNEZ, M. DEL CORO ARIZMENDI, and P. DAVILA. 1997. Pollination biology of two columnar cacti (*Neobuxbaumia mezcalaensis* and *Neobuxbaumia macrocephala*) in the Tehuacan Valley, central Mexico. *Amer. J. Bot.* 84:452–455.
- VAN DEVENDER, T.R., A.C. SANDERS, R.K. WILSON, and S.A. MEYER. 2000. Vegetation, flora and seasons of the Río Cuchujaqui, a tropical deciduous forest near Alamos, Sonora. In: R.H. Robichaux and D. Yetman, eds. The tropical deciduous forest of Alamos. biodiversity of a threatened ecosystem in México. University of Arizona Press, Tucson. Pp. 36–101.
- VAN DEVENDER, T.R., W.A. CALDER, K. KREBBS, A.L. REINA-G., S.M. RUSSELL, and R.O. RUSSELL. 2004. Hummingbird plants and potential nectar corridors for the rufous hummingbird in Sonora, Mexico. In: G.P. Nabhan, R.C. Brusca, and L. Holter, eds. Conserving migratory pollinators and nectar corridors in western North America. Arizona-Sonora Desert Museum and University of Arizona Press, Tucson.
- VILLA-R., B. 1966. Los Murciélagos de México. Universidad Nacional Autónoma de México. Instituto de Biología, México, D.F.
- WILKINSON, G.S., T.H. FLEMING, and J. WILKINSON. 1996. Migration and evolution of lesser long-nosed bats *Leptonycteris curasoae*, inferred from mitochondrial DNA. *Molec. Ecol.* 5: 329–339.



Austin, Daniel F, Felger, Richard Stephen, and Van Devender, Thomas R. 2005.
"NOMENCLATURE OF IPOMOEA ARBORESCENS (CONVOLVULACEAE) IN
SONORA, MEXICO." *SIDA, contributions to botany* 21, 1283–1292.

View This Item Online: <https://www.biodiversitylibrary.org/item/34585>

Permalink: <https://www.biodiversitylibrary.org/partpdf/163688>

Holding Institution

Missouri Botanical Garden, Peter H. Raven Library

Sponsored by

Missouri Botanical Garden

Copyright & Reuse

Copyright Status: In copyright. Digitized with the permission of the rights holder.

License: <http://creativecommons.org/licenses/by-nc-sa/3.0/>

Rights: <https://biodiversitylibrary.org/permissions>

This document was created from content at the **Biodiversity Heritage Library**, the world's largest open access digital library for biodiversity literature and archives. Visit BHL at <https://www.biodiversitylibrary.org>.