

# Opuntia Web: a resource for understanding and studying the *Opuntia* (Cactaceae, Opuntioideae) species of the United States

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## Keywords

cactus website, habitat photos, herbarium vouchers, National Library of Medicine, *Opuntias* of the United States, *Opuntia* species, original citation

## Abstract

Opuntia Web (<https://www.opuntiads.com/>) was built over the past 18 years. Nearly 100 species of United States-occurring *Opuntia* are described. Though initially validly published, many are unstudied by botanists today, perhaps owing to the fact that identification of *Opuntia* species is difficult because some organs are ephemeral, morphology is sometimes plastic, or many species have been conflated with others. The goal of Opuntia Web is to aid in the identification and study of the many USA-occurring Opuntias. We provide photographs taken in habitat, historical information, and other resources to help diagnose the various species.

## Introduction

Opuntias are unique and attractive cacti. They are often prominent components of many ecosystems. Additionally, they grow well in gardens and are popular for the distinctive look they add and their large and colorful flowers. However, there is often confusion surrounding the identification of the various species for a variety of reasons. For instance, many species have been synonymized and their names largely ignored; herbarium specimens are not always correctly identified; and many species are not mentioned in guidebooks. Herein, we identify nearly 100 United States-occurring *Opuntia* (L.) Mill. species (Table 1), and our website provides information about them to aid in their identification. Our goal is to unravel the conflicting and confusing information that encompasses United States-occurring opuntias.

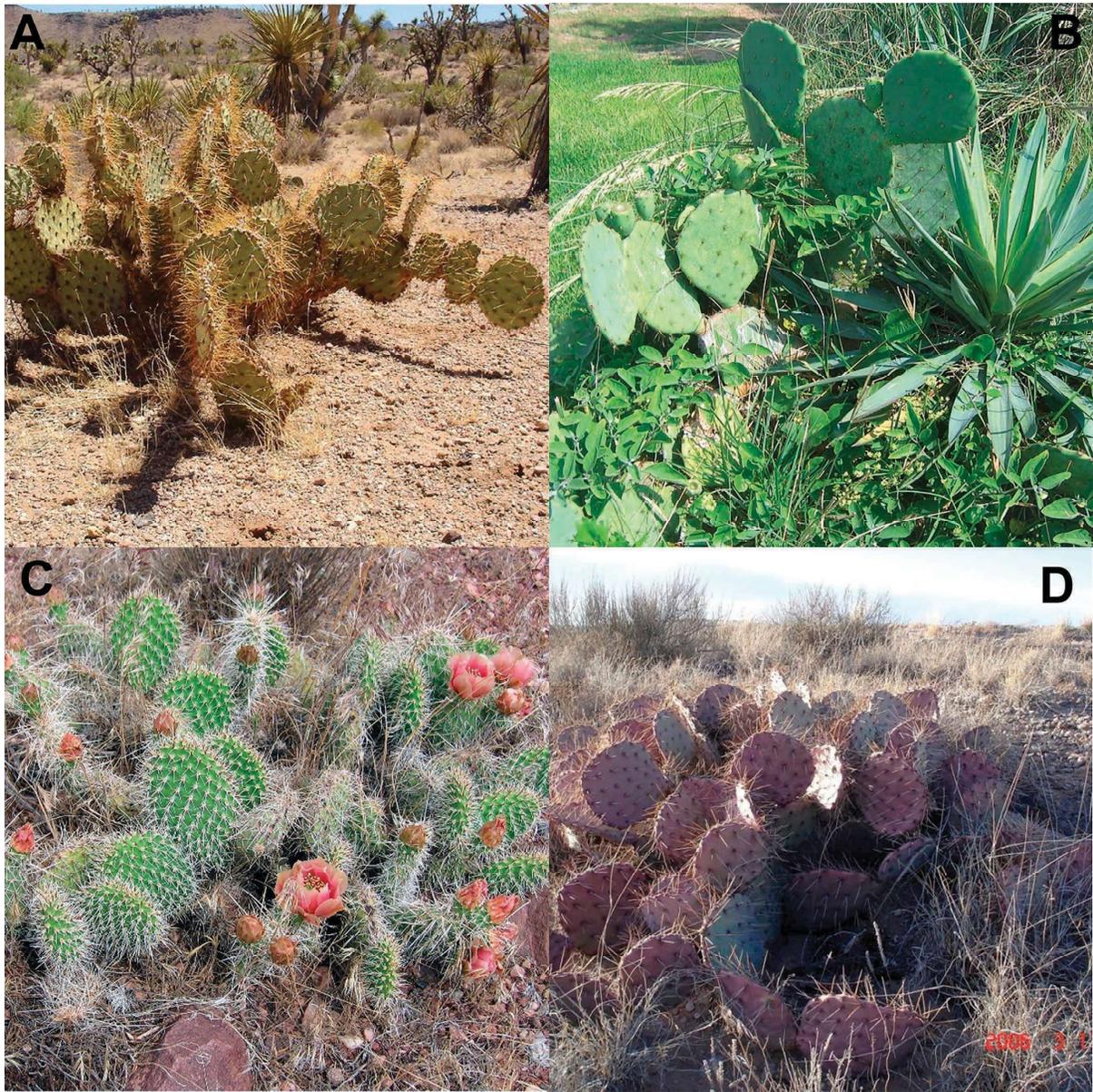
We have an editorial board consisting of a Publisher and Executive Editor (Joseph Shaw), Executive

Editor and Senior Scientific Editor (David J. Ferguson), Editor for the Mojave Desert (Nanette Hussey), and Editor for Florida (Daniel Green). Collectively, we visited Arizona to study cacti in their habitat (e.g., *O. curvispina* Griffiths); the southern Atlantic states to observe cacti in those regions (e.g., *O. tunoidea* Gibbes); the Great Plains to examine *O. polyacantha* Haw.; and New Mexico to study *O. gilvescens* Griffiths; and many more locations (Fig. 1). In fact, our Senior Scientific Editor visited multiple populations of *Opuntia* in every state where the genus has been reported, studied type specimens in multiple herbariums, visited type localities in the United States and Mexico, and has grown and observed living material for nearly all published names of USA-occurring *Opuntia* species. We present little- and well-known species. However, for the most part, we do not address horticultural selections of opuntias, nor discuss hybrids because they are so rare in nature.

**Table 1** *Opuntia* Species addressed on Opuntia Web with citations to recently published information. Taxa are listed alphabetically by row. For more information on the author(s) of the taxa, cf. POWO (<https://powo.science.keew.org/>) or IPNI ([www.ipni.org](http://www.ipni.org)).

<i>O. abjecta</i> , Majure et al., 2012b	<i>O. aciculata</i> , Newland and Crosswhite, 1985; Hunt, 2016	<i>O. alta</i> , Garcia-Morales, et al., 2022 ( <i>O. xalta</i> ); Shaw, 2025
<i>O. ammophila</i> , Majure, 2007	<i>O. anahuacensis</i> , Čato et al., 2023	<i>O. angustata</i>
<i>O. arenaria</i>	<i>O. arizonica</i>	<i>O. atrispina</i> , Griffith, 2001
<i>O. aurea</i>	<i>O. aureispina</i>	<i>O. austrina</i>
<i>O. azurea</i>	<i>O. basilaris</i>	<i>O. bentonii</i> , Shaw and Ferguson, 2025
<i>O. blakeana</i>	<i>O. cacanapa</i> , Shaw and Ferguson, 2024	<i>O. caesia</i>
<i>O. camanchica</i> , Griffith, 2003	<i>O. charlestonensis</i>	<i>O. chisosensis</i> , Ferguson, 1986
<i>O. chlorotica</i> var. <i>chlorotica</i>	<i>O. gosseliniana</i> ( <i>O. chlorotica</i> var. <i>gosseliniana</i> (F.A.C. Weber)) Ferguson, Majure et al., 2012b	<i>O. santa-rita</i> Griffiths&Hare Rose ( <i>O. chlorotica</i> var. <i>santa-rita</i> Griffiths & Hare), Majure et al., 2012b
<i>O. confusa</i> , Green and Ferguson, 2011	<i>O. covillei</i>	<i>O. curvo[i]spina</i> , Majure, 2022
<i>O. cyclodes</i>	<i>O. cymochila</i> , Majure et al., 2012b, POWO	<i>O. debreczyi</i>
<i>O. dillenii</i>	<i>O. diploursina</i>	<i>O. discata</i> , Green and Ferguson, 2011
<i>O. dulcis</i>	<i>O. engelmannii</i>	<i>O. ficus-indica</i>
<i>O. flavispina</i> *	<i>O. fragilis</i>	<i>O. fusco-atra</i>
<i>O. gilvescens</i> , Powell and Weedon, 2001; Green and Ferguson, 2011	<i>O. gomei</i> , Garcia-Morales, et al., 2022	<i>O. humifusa</i>
<i>O. keyensis</i> , Majure et al., 2012b	<i>O. laevis</i>	<i>O. lata</i> , Raf ssp. <i>lata</i> [Small] Majure,
<i>O. leptocarpa</i>	<i>O. lindheimeri</i>	<i>O. littoralis</i> , Mayer and Rebman, 2021
<i>O. lubrica</i> , Green and Ferguson, 2011	<i>O. mackensenii</i>	<i>O. macrarthra</i> , Holmes, 2016
<i>O. macrocentra</i>	<i>O. macrorhiza</i>	<i>O. martiniana</i> , Majure, 2022
<i>O. mesacantha</i> , Majure et al., 2017	<i>O. mojaviensis</i>	<i>O. nemoralis</i> , Majure et al., 2017
<i>O. nicholii</i>	<i>O. nitens</i> , Majure et al., 2017	<i>O. occidentalis</i>
<i>O. ochrocentra</i> , Majure et al., 2014	<i>O. orbiculata</i> , Majure, 2012b, POWO	<i>O. oricola</i> , Majure et al., 2012b
<i>O. phaeacantha</i>	<i>O. pinkavae</i> , Majure et al., 2012b	<i>O. polyacantha</i> var. <i>erinacea</i>
<i>O. polyacantha</i> var. <i>hystricina</i>	<i>O. polyacantha</i> var. <i>juniperina</i>	<i>O. polyacantha</i> var. <i>polyacantha</i>
<i>O. polyacantha</i> var. <i>rhodantha</i>	<i>O. polyacantha</i> var. <i>schweriniana</i>	<i>O. polyacantha</i> var. <i>utahensis</i>
<i>O. polycarpa</i> , Majure et al., 2017	<i>O. pottsii</i>	<i>O. pusilla</i>
<i>O. pyrocarpa</i> , Green and Ferguson, 2011	<i>O. riparia</i>	<i>O. rufida</i> , Köhler et al., 2023
<i>O. rugosa</i>	<i>O. sanguinicola</i>	<i>O. semispinosa</i>
<i>O. spinosibacca</i> , Griffith, 2003	<i>O. stricta</i>	<i>O. strigil</i> , Griffith and Porter, 2009
<i>O. tardospina</i>	<i>O. tortispina</i> , Majure et al., 2012b, POWO	<i>O. toumeyii</i>
<i>O. trichophora</i>	<i>O. tunoideae</i> , Holmes, 2016	<i>O. turbinata</i>
<i>O. valida</i>	<i>O. vaseyi</i> , Majure et al., 2012b	<i>O. woodsii</i>
<i>O. wootonii</i>	<i>O. xanthoglochla</i> , Majure et al., 2012a	<i>O. zebrina</i> , Majure, 2010
<i>O. zuniensis</i>		

\*Nomenclatural note: *Opuntia flavispina* (L.D.Benson) D.J.Ferguson, Joe J.Shaw, N.Hussey **stat. nov.** *Opuntia phaeacantha* var. *flavispi-*  
*na* L.D.Benson *Cactus & Succulent Journal* (US) 46(2): 79. 1974. Holotype: POM 306987 col. A.A.Nichol, Apr 1939, Alamo Cyn., Ajo  
Mountains, Organ Pipe Cactus NMon, AZ, alt. 2300 ft. [non *Opuntia flavispina* Hort.Berol. ex C.F.Först. 1846. nomen nudum]



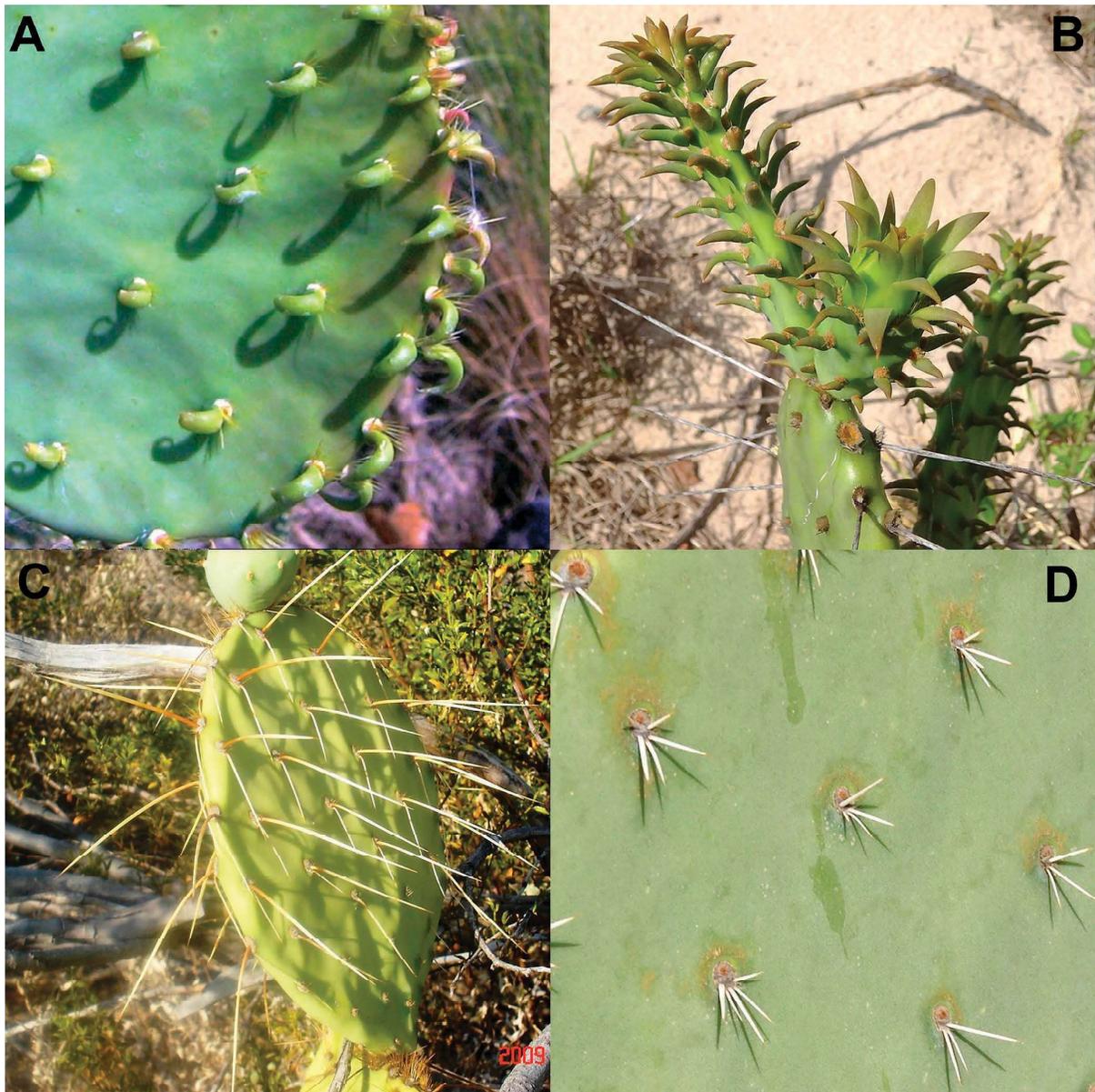
**Fig. 1** Examples of species and locations visited. (A) *Opuntia curvispina* Griffiths, northwest of Dolan Springs, Arizona. (B) *O. tunoidea* Gibbes, Edisto Beach, South Carolina. (C) *O. polyacantha* Haw. var. *polyacantha*, Great Plains. (D) *O. gilvescens* Griffiths, Belen, New Mexico. Photos: Cherie Labelle: B, David J. Ferguson: C, D, Joseph Shaw: A

## Materials and Methods

We researched plants extensively in habitat to understand their occurrence, sympatric associations, and populations, etc. We grew them in culture to examine the morphology of ephemeral organs (e.g., leaves), reproductive organs, and phenology close-up. We consulted herbarium specimens in person and online; historical photographs from the Smithsonian Institution Archives, GGN; Shaw, 2024, the current literature (e.g., Griffith 2003, Green and Ferguson 2011, Powell and Weedon, 2004, Majure et al., 2017); original citations; and multiple online resources, including BHL, CCH2, Flora of the Southeastern United States, GBIF, IDB, Internet Archive, IPNI,

NLM, POWO, SEINet, SERNEC, the Smithsonian Museum of Natural History Institution Department of Botanical Resources, Smithsonian Institution Archives, Smithsonian Institution Learning Lab, Tropicos, and WFO. Moreover, we corresponded and collaborated with other scientists.

We match all the species we characterize with their basionyms as we understand them, and we provide PDF copies of their original descriptions. For instance, the basionym for *O. atrispina* Griffiths was published in the Annual Report of the Missouri Botanical Garden, 21:172, 1910, and we provide a copy of that description. We consider the basionyms that we present to be the correct names of the taxa we describe.



**Fig. 2** Distinctive leaves and spines. (A) Strongly recurved leaves of *Opuntia cacanapa* Griffiths and Hare. (B) Thick, ovate, gently recurved leaves of *O. ammophila* Small. (C) Outstretched and deflexed, yellow spines of *Opuntia flavispina* (L.D.Benson) D.J.Ferguson, Joe J.Shaw, N.Hussey. (D) Divergent, erect, white spines of *O. discata* Griffiths. Photos: Daniel Green: B, Joseph Shaw: A, C, D

## DNA and Ploidy

As it becomes available, we include DNA-based evidence demonstrating the hybrid origin of certain species and/or their reticulate evolution, e.g., *O. spinosibacca* M.S.Anthony (Griffith 2003); that certain groups of species are constellations of similar-appearing taxa (Griffith and Porter 2009, Majure et al., 2012a); the occurrence of cryptic species (Majure 2022); phylogenetic relationships (Majure and Puente 2014); and that polyploidy has likely played an important role in speciation (e.g., Majure et al., 2012b, Granados et al., 2022). We provide ploidy information where it has been published (e.g., Weedin and Powell 1978, Pinkava and Parfitt 1988, Baker et al, 2009).

We also provide information about DNA sequences deposited at NLM (e.g., GenBank locus JQ245720 for *O. nemoralis* Griffiths at NLM). We are a living resource because we incorporate new information as it becomes available.

## Results

### Unstudied Species

Of the many *Opuntia* species in the United States, many have been unstudied since their original descriptions were published. Many botanists don't know about them because some species were placed in synonymy (e.g., Benson 1969a, 1969b, 1969c, and 1982),



**Fig. 3** *Opuntia phaeacantha* Engelm. in different seasons and locations. (A) Summer, Kingman, Arizona. (B) Early spring, Leeds, Utah (C) Late spring, Conchas Lake, New Mexico. (D) Winter, Mt. Potosi, Nevada.

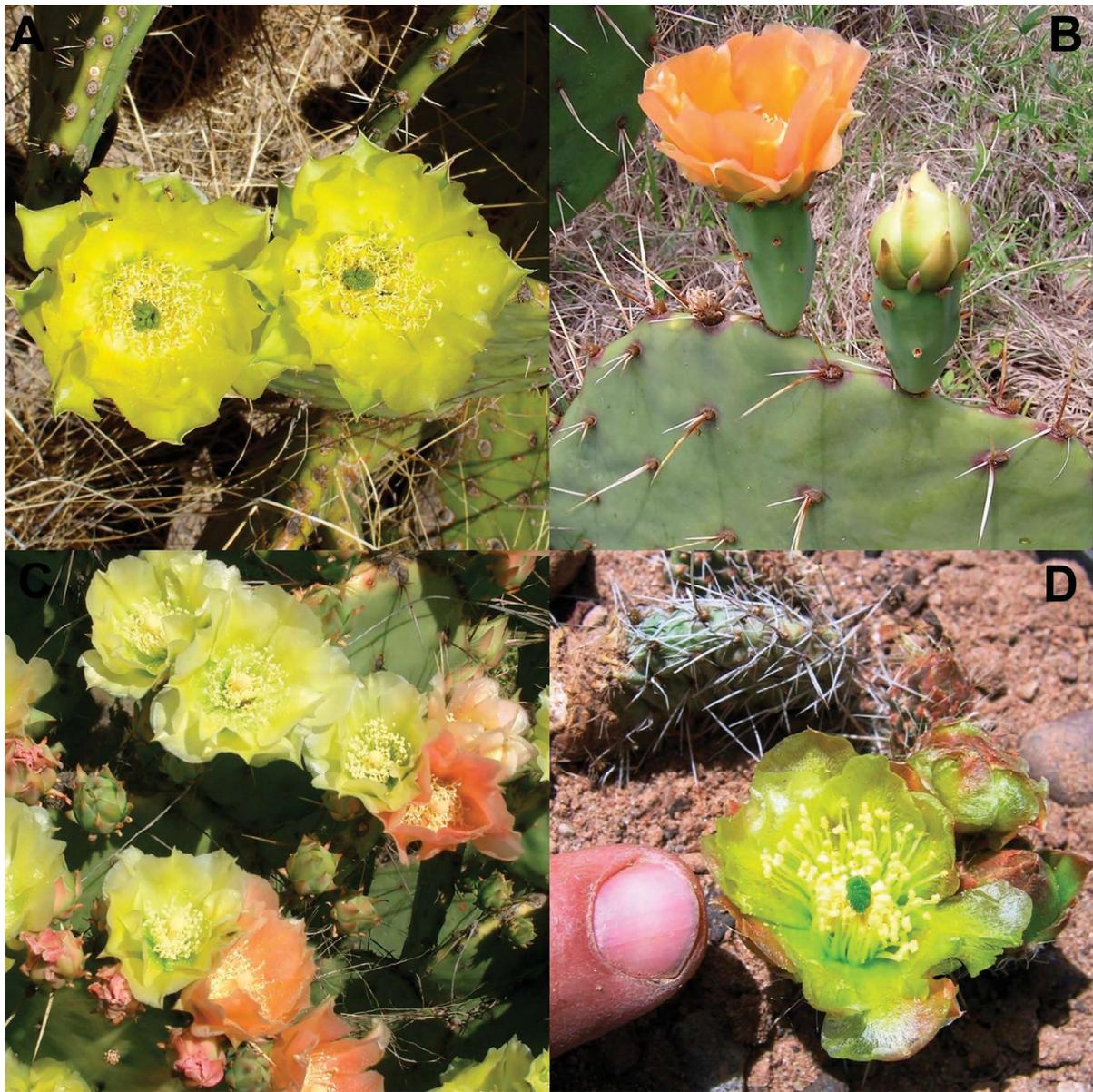
*Opuntia* phenotypes are sometimes difficult to interpret, species may be morphologically plastic (Majure 2007), or some authors advanced the hypothesis that various populations of opuntias are collections of hybrids and do not represent discrete species (e.g., Baxter, 1935; Benson, 1982; Nobel and Bobich, 2002; Parfit, 1991; Rebman and Pinkava, 2001), thereby negating interest in studying various taxa. Nonetheless, we document the existence of such species and provide evidence of the differences between them so that visitors to our website can understand the multiple species.

Some taxa are cryptic, and only close inspection can diagnose them (e.g., *Opuntia mesacantha* Raf. subsp. *mesacantha* and *O. mesacantha* Raf. ssp.

*lata* [Small] Majure). Thus, casual observation might indicate one taxon where there are two or more (e.g., Majure et al., 2017). We use the literature and photographs to untangle such species.

### Photographs

The greatest power of our website resides in its photographs. We provide over 2,000 photographs of plants, most taken in habitat and most taken by members of the Editorial Board. Even though *Opuntias* are plastic in morphology, we capture the look and feel of each species so that they may be differentiated. Unique leaves or spination are depicted (Fig. 2). Photographs are taken in different seasons or locations (Fig. 3). The flowers of multiple species are presented



**Fig. 4** *Opuntia* flowers (A) Open, yellow flowers of *Opuntia orbiculata* Salm-Dyck ex Pfeiff., dark green stigmas, Guadalupe Mountains National Park, Texas. (B) Orangish, afternoon flower of *O. pyrocarpa* Griffiths, Reimer's Ranch Park, Texas. (C) Flowers that open yellow and fade to pink, salmon, or apricot, pale stigmas, *O. atrispina* Griffiths, Brackettville, Texas. (D) Small flowers with green stigmas, *O. polyacantha* var. *schweriniana* (K.Schum.) Backeb., Colorado. Photos: David J. Ferguson: D, Joseph Shaw: A, B, C

(Fig. 4). Also, we capture the phenology of many individual species (Fig. 5). Moreover, we provide photographs depicting the aspects of plants in their habitat (Fig. 6). Finally, for all species, we provide images of herbarium vouchers (over 700 in total) that we judge appropriately represent them (Fig. 7).

### Current Information

We keep up to date and provide references and access to current literature. Though some species were not studied for many years, over 45% of the species we present have been resurrected and mentioned or addressed in the recent literature (Table 1).

### Summary

Some *Opuntia* species were described as long as 100 years or more ago and have been missing from the literature but are entering the mainstream. Many are addressed in the recent literature (Table 1), and we describe them and provide citations. We hope that these species will soon be entered into guidebooks and herbariums to assist in their identification in habitat. Likewise, we hope their recognition and our treatment of them in *Opuntia* Web will inspire ecological studies, enabling conservation efforts.

For instance, multiple large Western *Opuntia* species are conflated with *O. engelmannii* Salm-Dyck ex Engelm., but we feel they are distinct, and we present



**Fig. 5** *Opuntia cymochila* Engelm. (A) Flowers showing characteristic ruffled petaloid tepals. (B) Fruit with uniquely pinched umbilical rim. (C) Full plant in bloom displaying shaggy look. (D) Close-up of cladode with reflexed spines. Photos: David J. Ferguson

them on Opuntia Web. One of these is *O. orbiculata* Salm-Dyck ex Pfeiff., which was ignored for over 100 years but is now accepted as a full species by POWO. The misidentification of *O. orbiculata* and conflation with *O. engelmannii* probably causes conclusions about that latter taxon to be distorted. Small species have also been ignored over time, but are now recognized by POWO (e.g., *O. tortispina* Engelm. & J.M. Bigelow, *O. cymochila* Engelm. & J.M. Bigelow). We describe both of these small species.

We are a strong resource for people who want to enjoy or study opuntias of the United States. We present historical and current information, including reproductions of the actual text of original

descriptions, photographs in habitat, images of herbarium vouchers, text discussions, and references to available DNA data. Where available, we provide links to recently published information or opinions. We know that future studies will provide information that will change how we treat the various species. And we will incorporate that information into Opuntia Web as it becomes available. Opuntia Web is a living resource.

## Acknowledgements

We thank the many digital libraries, herbaria, and biodiversity data portals we consulted—including the Biodiversity Heritage Library, the Consortium

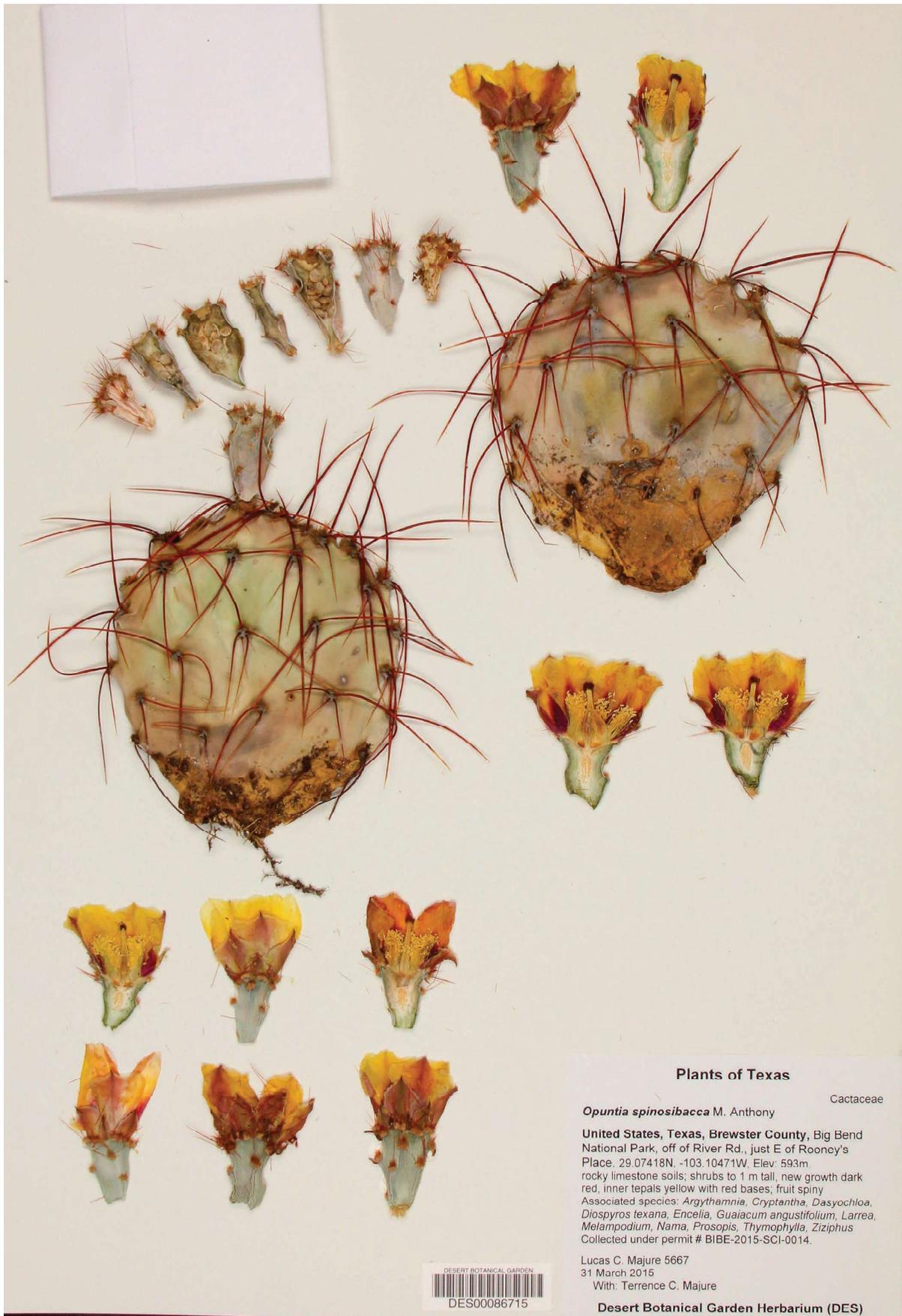


**Fig. 6** (A) *Opuntia alta* Griffiths, juvenile tree, Mathis, Texas. (B) *O. laevis* J.M.Coult, plants growing along canyon walls, southern Arizona. Photos: David J. Ferguson: B, Joseph Shaw: A

of California Herbaria (CCH2), the Global Biodiversity Information Facility (GBIF), SEINet, and the Smithsonian Institution's Learning Lab—for access to digitized literature, specimen images, and occurrence records. We also thank Paul Adanick and Root Gorelick for their careful reviews of the manuscript and for constructive suggestions that improved it.

## Literature Cited

- Baker, M. A., J. P. Rebman, B. Parfitt, D. Pinkava, et al. 2009. Chromosome numbers of miscellaneous angiosperm taxa. *Journal of the Botanical Research Institute of Texas* 3(1): 279–283.
- Baxter, E. M. 1935. *California cactus: a complete and scientific record of the cacti native in California*. 1st ed. Abbey San Encino Press.
- Benson, L. 1969a. *The native cacti of California*. Stanford University Press.
- Benson, L. 1969b. Cactaceae. In: C. L. Lundell (Ed.), *Flora of Texas, Vol. II*, pp. 221–317. Texas Research Foundation.
- Benson, L. 1969c. *The Cacti of Arizona*. 1st Ed., University of Arizona Press.
- Benson, L. 1982. *The Cacti of the United States and Canada*. Stanford University Press. 1st Ed. <https://archive.org/details/cactiofunitdsta0000bens/page/930/mode/2up>.
- Benson, L., and D. L. Walkington. 1965. The southern Californian prickly pears—Invasion, adulteration, and trial-by-fire. *Annals of the Missouri Botanical Garden* 52: 262–273. <https://doi.org/10.2307/2394792>.
- BHL. Biodiversity Heritage Library. <https://www.biodiversitylibrary.org/>. Accessed October 2025.
- Ćato, S., and S. Bogdanović. 2023. *Euphorbia hypericifolia* L. and *Opuntia anahuacensis* Griffiths: two new, potentially invasive species in Croatia. In: 5th Croatian Symposium on Invasive Species. <http://www.ekolosko-drustvo.hr/5CSIS-Book-of-Abstracts-final-web.pdf> (Poster No. 40). Accessed October 2025.
- CCH2. Consortium of California Herbaria. CCH2 Portal. <https://cch2.org/portal/>. Accessed October 2025.
- Ferguson, D. J. 1986. *Opuntia chisosensis* (Anthony) comb. nov. *Cactus and Succulent Journal* 58: 124–125.
- Ferguson, D. J. 1987. *Opuntia cymochila* Eng. & Big.: a species lost in the shuffle. *Cactus and Succulent Journal* 59: 256–260.
- García-Morales, L. G., J. García-Jiménez, R. Contreras-Medina, O. Alcántara-Ayala, et al. 2022. Diversity, distribution, and conservation of the Cactaceae (Caryophyllales) from Tamaulipas, Mexico. *Plant Biosystems* 156(6): 1405–1421. <https://doi.org/10.1080/11263504.2022.2056648>.
- GBIF. Global Biodiversity Information Facility. <https://www.gbif.org/>. Accessed October 2025.
- GGN, Griffiths' Glass Negatives. <https://opuntiads.com/griffiths>. Accessed October 2025.
- Gorelick, R. 2022. Curved-spined Opuntias. *Cactus and Succulent Journal* 94(1): 25–27. <https://doi.org/10.2985/015.094.0104>.
- Granados-Aguilar, X., U. Rosas, A. González-Rodríguez, and S. Arias. 2022. The prickly problem of interwoven lineages: hybridization processes in Cactaceae. *Botanical Sciences* 100(3): 797–813. <https://doi.org/10.17129/botsci.3065>.
- Green, C.W., D.J. Ferguson. 2011. *Pricklypears commonly found in the United States and northern Mexico*. Self-published.
- Griffith, M. P. 2001. Experimental hybridization of northern Chihuahuan Desert region *Opuntia* (Cactaceae). *Aliso: A Journal of Systematic and Floristic Botany* 20: 37–42. doi:10.5642/aliso.20012001.06.
- Griffith, M. P. 2003. Using molecular evidence to elucidate reticulate evolution in *Opuntia* (Cactaceae). *Madroño* 50(3): 162–169. <https://www.jstor.org/stable/41425511>.
- Griffith, M. P., and J. M. Porter. 2009. Phylogeny of Opuntioideae (Cactaceae). *International Journal of Plant Sciences* 170(1): 107–116. <https://doi.org/10.1086/593048>.



**Fig. 7** *Opuntia spinosibacca* Anthony, herbarium voucher, collector L.C. Majure, Desert Botanical Garden Record No. DES00086715 (retrieved from SEINet).

- Holmes, K. 2016. Morphological and ecological characterization of *Opuntia* Miller on the coast of South Carolina. M.S. Thesis, Plant and Environmental Science, Clemson University. [https://open.clemson.edu/all\\_theses/2466/](https://open.clemson.edu/all_theses/2466/). Accessed October 2025.
- Hunt, D. 2016. CITES Cactaceae checklist. Royal Botanic Gardens, Kew, Kew, UK, 3rd Ed. <https://www.kew.org/sites/default/files/2019-02/CITES%20Cactaceae%20Checklist%20Third%20Edition.pdf>.
- IDB. Integrated Digitized Biocollections (iDigBio). <https://www.idigbio.org/>. Accessed October 2025.
- Internet Archive. <https://archive.org/>. Accessed October 2025.
- IPNI. International Plant Names Index. <https://www.ipni.org/>. Accessed October 2025.
- Köhler, M., M. Reginato, J.-J. Jin, and L. C. Majure. 2023. More than a spiny morphology: plastome variation in the prickly pear cacti (Opuntieae). *Annals of Botany* 132(4): 771–786. <https://doi.org/10.1093/aob/mcad098>.
- Majure, L. C. 2007. The ecology and morphological variation of *Opuntia* (Cactaceae) species in the mid-south, United States. M.S. Thesis, Department of Biological Sciences, Mississippi State University. <https://scholarsjunction.ms-state.edu/td/4322/>. Accessed October 2025.
- Majure, L. C. 2010. Towards an evolutionary understanding of the *Opuntia humifusa* complex of North America. *Cactus and Succulent Journal* 82(4): 156–163. <https://doi.org/10.2985/015.082.0404>.
- Majure, L. C. 2022. On the origin of the two putative allopolyploids, *Opuntia curvispina* and *O. martiniana* (Cactaceae): A case of cryptic speciation in prickly pear cacti. *Journal of the Botanical Research Institute of Texas* 16(1): 317–333. <https://journals.brit.org/jbrit/article/view/1235/>.
- Majure, L. C., and G. N. Ervin. 2008. The *Opuntias* of Mississippi. *Haseltonia* 14: 111–126. <https://doi.org/10.2985/1070-0048-14.1.111>.
- Majure, L. C., and R. Puente. 2014. Phylogenetic relationships and morphological evolution in *Opuntia* s. str. and closely related members of tribe Opuntieae. In: *Further studies in the Opuntioideae (Cactaceae) (Succulent Plant Research 8)*, pp. 9–30. DH Books, Milborne Port, UK.
- Majure, L. C., D. E. Soltis, P. S. Soltis, and W. S. Judd. 2014. A case of mistaken identity: *Opuntia abjecta*, long lost in synonymy under the Caribbean species, *O. triacantha*, and a reassessment of the enigmatic *O. cubensis*. *Brittonia* 66(2): 118–136. <https://doi.org/10.1007/s12228-013-9307-z>.
- Majure, L. C., R. Puente, M. P. Griffith, W. S. Judd, et al. 2012b. Phylogeny of *Opuntia* s.s. (Cactaceae): Clade delineation, geographic origins, and reticulate evolution. *American Journal of Botany* 99(5): 847–864. <https://doi.org/10.3732/ajb.1100375>.
- Majure, L. C., W. S. Judd, P. S. Soltis, and D. E. Soltis. 2012a. Cyto geography of the *Humifusa* clade of *Opuntia* s.s. Mill. (Cactaceae, Opuntioideae, Opuntieae): correlations with Pleistocene refugia and morphological traits in a polyploid complex. *Comparative Cytogenetics* 6(1): 53–77. <https://doi.org/10.3897/CompCytogen.v6i1.2523>.
- Majure, L. C., W. S. Judd, P. S. Soltis, and D. E. Soltis. 2017. Taxonomic revision of the *Opuntia humifusa* complex (Opuntieae: Cactaceae) of the eastern United States. *Phytotaxa* 290(1): 1–65. doi:10.11646/phytotaxa.290.1.1.
- Mayer, M. S., and J. P. Rebman. 2021. Evolution of the chollas (Cactaceae). *Madroño* 68(2): 109–131. <https://doi.org/10.3120/0024-9637-68.2.109>.
- Newland, K. C., and F. S. Crosswhite. 1985. Cacti in the Living Plant Collection of the Boyce Thompson Southwestern Arboretum. *Desert Plants* 7(1): 3–30. <http://hdl.handle.net/10150/554201/>.
- NLM. National Library of Medicine. <https://www.ncbi.nlm.nih.gov/>. Accessed October 2025.
- Nobel, P. S., and E. G. Bobich. 2002. Evolution and Systematics. In: *Cacti: biology and uses*, P. S. Nobel (ed.). University of California Press.
- Opuntia Web. <https://www.opuntiaads.com/>. Accessed October 2025.
- Parfitt, B. D. 1991. Biosystematics of the *Opuntia polyacantha* complex (Cactaceae) of western North America. Ph.D. Dissertation, Arizona State University, 115 pp. <https://www.proquest.com/openview/f3569da-3296f108a9725796abb9dee78/1/>. Accessed October 2025.
- Parfitt, B. D., and D. J. Pinkava. 1988. Nomenclatural and systematic reassessment of *Opuntia engelmannii* and *O. lindheimeri* (Cactaceae). *Madroño* 35(4): 342–349. <https://www.jstor.org/stable/41424715>.
- Pinkava, D. J., and B. D. Parfitt. 1982. Chromosome numbers in some cacti of western North America. IV. *Bulletin of the Torrey Botanical Club* 109(1): 121–128. <https://doi.org/10.2307/2996251>.
- Pinkava, D. J., B. D. Parfitt, M. A. Baker, and R. D. Worthington. 1992. Chromosome numbers in some cacti of western North America—VI, with nomenclatural changes. *Madroño* 39(2): 98–113. <https://www.jstor.org/stable/41424895>.
- Powell, A. M., and J. F. Weedon. 2001. Chromosome numbers in Chihuahuan Desert Cactaceae. III. Trans-Pecos Texas. *American Journal of Botany* 88(3): 481–485. <https://doi.org/10.2307/2657113>.
- Powell, A. M., and J. Weedon. 2004. *Cacti of the Trans-Pecos and Adjacent Areas*. Texas Tech University Press.
- POWO. Plants of the World Online, Royal Botanic Gardens, Kew. <https://powo.science.kew.org/>. Accessed October 2025.
- Rebman, J. P., and D. J. Pinkava. 2001. *Opuntia* cacti of North America: an overview. *The Florida Entomologist* 84(4): 474–483. <https://doi.org/10.2307/3496374>.
- SEINet Portal Network. <https://swbiodiversity.org/seinet/index.php>. Accessed October 2025.
- SERNEC Data Portal. <https://sernecportal.org/portal/>. Accessed October 2025.
- Shaw, J. 2024. Griffith's glass plate photographic negatives of *Opuntia*: a historical resource. *Cactus and Succulent Journal* 96(3): 261–267. <https://doi.org/10.2985/015.096.0306>.
- Shaw, J. 2025. *Opuntia alta* Griffiths – synonyms and description (Cactaceae, Opuntioideae). *Bradleya* 43: 92–98. <https://doi.org/10.25223/brad.n43.2025.a11>.
- Shaw, J., and D. J. Ferguson. 2024. *Opuntia cacanapa* and *O. cacanapa* 'Ellisiana'. *Cactus and Succulent Journal* 96: 279–282. <https://doi.org/10.2985/015.096.0308>.
- Shaw, J., and D. J. Ferguson. 2025. *Opuntia bentonii*: a Texas Gulf Coast beach cactus. *Journal of the Botanical Research Institute of Texas* 19(1): 17–26. <https://doi.org/10.17348/jbrit.v19.i1.1388>.

- Small, J. K. 1933. *Manual of the southeastern flora: being descriptions of the seed plants growing naturally in Florida, Alabama, Mississippi, eastern Louisiana, Tennessee, North Carolina, South Carolina and Georgia*. University of North Carolina Press. <https://www.biodiversitylibrary.org/bibliography/696/>.
- Smithsonian Institution Archives. David Griffiths Collection (glass plate negatives). Record Unit 7370. [https://siarchives.si.edu/collections/siris\\_arc\\_217526/](https://siarchives.si.edu/collections/siris_arc_217526/). Accessed October 2025.
- Smithsonian Institution Learning Lab. Learning Lab. <https://learninglab.si.edu/>. Accessed October 2025.
- Smithsonian Museum of Natural History, Department of Botany. Collections Search. <https://collections.nmnh.si.edu/search/botany/>. Accessed October 2025.
- Tropicos, Missouri Botanical Garden. <https://www.tropicos.org/>. Accessed October 2025.
- Weakley, A.S., and Southeastern Flora Team. 2025. *Flora of the Southeastern United States* Web App. University of North Carolina Herbarium, North Carolina Botanical Garden. [fsus.ncbg.unc.edu](https://fsus.ncbg.unc.edu). Accessed October 2025.
- Weedin, J. F., and A. M. Powell. 1978. Chromosome numbers in Chihuahuan Desert Cactaceae. Trans-Pecos Texas. *American Journal of Botany* 65(4): 531–537. <https://doi.org/10.2307/2442586>.
- World Flora Online (WFO). <https://wfpplantlist.org/>. Accessed October 2025.
- Yesson, C., R. T. Bárcenas, H. M. Hernández, M. de la Luz Ruiz-Maqueda, et al. 2011. DNA barcodes for Mexican Cactaceae—plants under pressure from wild collecting. *Molecular Ecology Resources* 11(6): 775–783. <https://doi.org/10.1111/j.1755-0998.2011.03009.x>.

*Editor's note:* see my editorial in this issue for some different perspectives on *Opuntia* taxonomy.