

## **Opuntia macrocentra and Opuntia azurea: Two Attractive and Often Confused Taxa**

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1: *Opuntia macrocentra*

# *Opuntia macrocentra* and *Opuntia azurea*: two attractive and often confused taxa

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*Opuntia macrocentra* Engelm. (Fig. 1) was described in 1856 from a specimen from the “sand hills of the Rio Grande, near El Paso”, Texas. Later lectotypification assigned the same locality. The ploidy level of the specimen from this locality is unknown but likely tetraploid. *Opuntia azurea* Rose was named in 1909 from a specimen from Mexico (Fig. 2). The ploidy level of the type Mexican

specimen is unknown but all populations assigned to this species by Powell and Weedin (2004), including var. *azurea*, from Mexico, are diploids. The Macrocentra Clade (Majure, et al., 2023) includes *O. chlorotica*, *O. azurea*, *O. aureispina* (*O. azurea* var. *aureispina*), *O. macrocentra*, and *O. chisosensis*. All are diploids ( $2n = 2x = 22$ ) except *O. macrocentra* which is tetraploid ( $2n = 4x = 44$ ).





2: *Opuntia azurea*

Gorelick (2023), in a lengthy presentation, with no new data, asserted that *Opuntia macrocentra* and *Opuntia azurea* are conspecific. He ignored the differences in ploidy levels and other characteristics between these taxa. Gorelick made several assumptions that are based entirely on morphological data. I will address some of my major objections to his treatment of the two species.

Gorelick cited Powell and Weedin (2004) as “sometimes” referring specimens from the Big Bend area of Texas to *Opuntia azurea*. In fact, Powell and Weedin consistently assigned the diploid plants from Brewster, Jeff Davis, Presidio, Pecos and Crane Counties, Texas to *Opuntia azurea*. They cited 8 diploid plants from Hudspeth and Culbertson Counties, Texas as “tentatively” referred to *Opuntia macrocentra*, but those plants are obviously misidentified since they are diploid. Powell and Weedin remarked that the two species were difficult to distinguish by morphology alone but the comment applied mainly to limited areas of contact. Powell and Weedin (2004) described 4 diploid populations, in the Big Bend area of Texas, as varieties of *Opuntia azurea*. Only *O. azurea* var. *diplopurpurea* actually

contacts *Opuntia macrocentra* and triploid hybrids have not been detected.

*Opuntia macrocentra* differs from *O. azurea* in generally not having radial spines, larger and more rounded cladodes, more numerous areoles, and less distance between areoles (Figs. 3–5). Contrary to Gorelick’s claim, most populations of *O. azurea* can be distinguished from *O. macrocentra*. Most of Gorelick’s photos are readily identifiable. Figures 3, 5, 6, 7, 10, 14, and 16 in Gorelick (2023) are clearly of *Opuntia azurea*.

Gorelick cites several older literature references such as Hunt et al. (2006), Pinkava (2003), etc., that were published before the major work on Texas Cactaceae by Powell and Weedin (2004) was published or widely known. I cannot locate Gorelick’s citation of Pinkava (2013) in his literature cited, so that may be an error.

Gorelick cited Pinkava (2003) that *O. chisosensis* was perhaps related to the *O. azurea* complex. He also cited Ferguson (1986) who postulated that *O. chisosensis* is most closely related to the *Opuntia phaeacantha* complex, in which he included *O. macrocentra*. Majure et al. (2012, 2023) demonstrated in a well-supported molecular





3: Classic pad, spine, and areole structures of *Opuntia macrocentra*

phylogeny, that *O. macrocentra* is related to *O. chlorotica*, *O. chisosensis*, *O. azurea* var. *aureispina* and *O. azurea* var. *parva*, while *O. phaeacantha* is an allohexaploid derived from a member of the *Scheerianae* group, which includes *O. engelmannii*, and the Macrocentra Clade.

Gorelick stated that *O. macrocentra* is “usually” tetraploid. *Opuntia macrocentra* is always tetraploid. The 8 diploid plants from Hudspeth and Culbertson Counties, Texas, cited by Powell and Weedon (2004) as “tentatively” identified as *O. macrocentra* are obviously misidentified. It would make little sense that diploid and tetraploid populations would occur in *O. macrocentra* since there is a considerable reduction in fertility that would occur between the two different ploidy levels. It is not uncommon in closely related species, especially a derived tetraploid like *O. macrocentra*, to have populations and individual plants that more closely resemble one ancestor in morphology. That is one reason that chromosome data is essential in determining species boundaries. *Opuntia macrocentra* may have been derived from *O. azurea*, *O. chisosensis*, or an earlier diploid relative.

Gorelick stated that it is “silly naming new cryptic species merely due to ploidy differences”. He did not

recognize that diploids are ancestral and that there exists a strong fertility barrier in the progeny of any potential hybridization between diploids and derived tetraploids. Such a fertility barrier serves as a well-marked species division between diploids and tetraploids. This barrier is well supported by the general lack of outbreeding triploid populations in *Opuntia*. Gorelick cited Rowley (2007) asserting that polyploidy occurs far too readily for chromosome counts to have any useful function in taxonomy and that triploids are not an evolutionary dead end. Neither of these assertions are supported by evidence and the published cytogenetic data disagrees strongly with this concept. There are no outbreeding populations of triploid *Opuntia* although triploids may have some limited fertility as the seed parent, especially when hybridized to a diploid. The few triploids with a distinct population occur in plants like *Cylindropuntia bigelovii*, which is triploid over most of its range (Pinkava, 2002) and these generally propagate by vegetative means. That simply is a dead end in any evolutionary sense. A species chromosome count and chromosome structure are among the most stable characteristics that can be used in the taxonomy of any group, including *Cactaceae*. Many genera of *Cactaceae* are



composed entirely of diploid species that have been maintained at that ploidy level for millions of years. Genera like *Pediocactus* Britton & Rose and *Sclerocactus* Britton & Rose, for example, are always diploid regardless of the morphological or DNA sequence differences. Other genera such as *Opuntia* (L.) Mill., *Cylindropuntia* (Engelm.) F.M. Knuth, and *Echinocereus* Engelm. are rich in polyploids and reticulate evolution (speciation by hybridization), but populations with uneven counts have reduced fertility. Morphology in polyploids is often misleading and chromosome counts and DNA sequence data are far more reliable. Chromosome counts are very stable compared to morphology. In my 5 decades of chromosome analysis work, I have been constantly impressed with the stability of chromosome number and structure in both plant and animal species. Plants of *Opuntia* are no exception. I have analyzed plants of *O. trichophora* (Engelm. & J.M. Bigelow) Britton & Rose from 5 states and all yielded the same diploid chromosome complement. *Opuntia erinacea* Engelm. & J.M. Bigelow, from throughout its wide range, have all been documented as tetraploids and all *O. nicholii* L.D. Benson and *O. phaeacantha* Engelm. analyzed from many localities in Utah and Arizona, have been hexaploids. This consistency of counts has been the rule in all *Opuntia* species that I have analyzed. Chromosome count or ploidy level is not the highly variable character that Gorelick (2023) asserts. Chromosome counts are extremely stable and important as a reliable indicator of species boundaries, sometimes more reliable than morphology. Obtaining chromosome counts is essential in resolving species in *Opuntia* (Stock et al., 2023) and must also serve as a preliminary step before DNA sequence studies to assure accurate identification of source.

Gorelick (2023) stated that *Opuntia macrocentra* (Fig. 6) has only central/major spines with no radial spines and included “even those in photos from Brewster Co., Texas that others might call *Opuntia azurea*.” Some of the photos presented of plants from Brewster County do appear to have a few radial spines. Powell and Weedin (2004) described multiple central and radial spines for at least two of the diploid *Opuntia azurea* varieties they analyzed from Brewster Co., Texas. According to Gorelick, that would support their exclusion from *Opuntia macrocentra*.

To finalize my objections to Gorelick's inclusion of *Opuntia azurea* (Fig. 7) within his circumscription of *O. macrocentra*, I point to a very recently published comprehensive phylogeny. Majure, et al. (2023) presented a well-supported molecular phylogeny that clearly demonstrates that *Opuntia azurea* var. *parva* and var. *aureispina* (as *O. aureispina*) are not the same species as *Opuntia macrocentra*. Their data indicate these two species are related but places



4: Classic pad, spine, and areole structures of *Opuntia azurea*



5: Young pads of *Opuntia azurea*



6: *Opuntia macrocentra* in flower



7: *Opuntia azurea* flower with a pollinating visitor.

*Opuntia chisosensis* closer to *Opuntia macrocentra*. It is possible that *O. chisosensis*, which is diploid, or an earlier diploid relative of both *O. azurea* and *O. chisosensis*, may have participated in forming *Opuntia macrocentra*. Additional analyses of molecular data are needed to further resolve the relationship of tetraploid *O. macrocentra* to the diploids *O. azurea* and *O. chisosensis*, but there is substantial evidence that *O. macrocentra* is not conspecific with *O. azurea*.

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