CHROMOSOME NUMBERS IN CHIHUAHUAN DESERT CACTACEAE. II. TRANS-PECOS TEXAS

Chromosome numbers are reported for 39 taxa of Cactaceae, most from the Trans-Pecos region of the Chihuahuan Desert. Of the 75 counts reported, eight are first reports for the taxon: *Coryphantha duncanii* (2n = 22), *Coryphantha hesteri* (2n = 22), *Coryphantha ramillosa* (2n = 22), *Echinocereus viridiflorus* var. *correllii* (n = 11), *Echinocereus viridiflorus* var. nov. (n = 11), *Opuntia atrispina* (2n = 22), *Opuntia kleiniae* var. nov. (2n = ca. 44), *Opuntia tunicata* var. *davisii* (2n = 22). Two counts were found to represent new ploidy levels, *Echinocereus stramineus* (n = 22) and *Opuntia strigil* (n = 22). Chromosome numbers are now known for 88 of the 90 to 100 taxa of cacti in the Trans-Pecos.

This paper completes our initial cytological study of Trans-Pecos cacti and is the second in a series of papers (cf. Weedin and Powell, 1978*a*) that lead toward the understanding of taxonomic problems in cacti of the Chihuahuan Desert. General discussions of cytology in the cactus family may be found in Weedin and Powell (1978*a*) and Pinkava et al. (1985).

In this and previous work (Weedin and Powell, 1978*a*), we report that 55.1% of the subfamily Opuntioideae and 15.2% of the Cactoideae have polyploid populations in the Trans-Pecos for a combined total of 26.1% polyploidy. These percentages are similar to those reported for primarily western North American taxa (Opuntioideae, 52.4%; Cactoideae, 19.4%) at approximately the same latitude (Pinkava and Parfitt, 1982; Pinkava et al., 1985) and for dicots (30.2%) of the Chihuahuan Desert as a whole (Powell and Sloan, 1975).

Chromosome numbers were determined by observations of acetocarmine squashes of microsporocytes or alcohol-HCl-carmine squashes of root tips (Weedin and Powell, 1978*a*). The approximate chromosome counts were due to technique (primarily tight squashes involving higher chromosome numbers). Vouchers of specimens are deposited in the herbarium of Sul Ross State University. Nomenclature follows that of Benson (1969, 1982) and Glass and Foster (1977).

**Echinocereus viridiflorus* Engelm. var. *correllii* L. Benson. n = 11. Texas, Brewster Co., 4.8 km SE of Marathon. *BHW s.n.* Meiotic observations from the *E. viridiflorus* complex continue to indicate consistent diploidy with regular meiosis (Pinkava et al., 1977, 1985; Kolle, 1978; Weedin and Powell, 1978*a*, 1978*b*; Leuck, 1980; Ross, 1981). Leuck (1980) considers all of the small-flowered members of the complex (including *E. chloranthus* and *E. russanthus*) as varieties of *E. viridiflorus*, with one exception (*Echinocereus davisii* A. D. Houghton).

Echinocereus viridiflorus Engelm. var. *cylindricus* (Engelm.) Engelm. ex Rümpler. n = 11. Texas, Brewster Co., Alpine, Sul Ross Hill, *JFW 424*; 2 km E of Alpine, *Clark 862*; Culberson Co., 5.3 km N of Kent, *DOK 91*; El Paso Co., Fusselman Canyon, *DOK 82*; Trans-Mtn. Hwy., *DOK 76*; Fusselman Canyon, *DOK 95*.

**Echinocereus viridiflorus* Engelm. n = 11. Texas, Jeff Davis Co., Tricky Gap, *DOK 90*. Leuck (1980) considers this collection to represent an undescribed variety.

Mammillaria wrightii Engelm. var. *wrightii*. 2n = 22. New Mexico, Doña Ana Co., W side of Organ Mountains, *JFW 1271*. A minority of root tip cells showed a count of 2n = ca. 44.

Opuntia arenaria Engelm. 2n = 22. New Mexico, Doña Ana Co., near Anthony, *Boke s.n.*

**Opuntia atrispina* Griff. 2n = 22. Texas, Uvalde Co., Hwy. 55, 27.7 km S of Montell, *JFW 1430a*. Collections that probably represent the hexaploid *Opuntia phaeacantha* var. *major* were incorrectly identified in Weedin and Powell (1978*a*) as *O. atrispina* (*JFW 363, 462*). These hexaploid plants also possess black spines with yellowish tips. There is doubt that populations of *O. atrispina* exist in the Trans-Pecos.

Opuntia ellisiana Griff. n = 11. Texas, Brewster Co., Alpine, Sul Ross St. Univ. campus, *JFW 495* (cultivated). A plant attributable to this species (*JFW 303a*) was incorrectly identified in Weedin and Powell (1978*a*) as *Opuntia ficus-indica* Mill. Several investigators have identified spineless pads on herbarium sheets as *O. ficus-indica*. However, *O. ficus-indica* occurs only as an occasional cultivar in the Trans-Pecos.

**Opuntia kleiniae* DC. 2n = ca. 44. Texas, Brewster Co., BBNP, near Castolon, *JFW 1256*; Stillwell Crossing, *JFW 1521b*. The *O. kleiniae* populations along the Rio Grande appear to represent an entity taxonomically distinct from the *O. kleiniae* var. *kleiniae* populations in the Davis Mts.

Opuntia lindheimeri Engelm. aff. var. *lindheimeri*. 2n = ca. 66. Texas, Brewster Co., BBNP, Rio Grande Village, *JFW 1171*.

Opuntia cf. *lindheimeri* Engelm. var. *lindheimeri*. 2n = ca. 66. New Mexico, Guadalupe Co., W of Anton Chico, *JFW 1352*. According to Weniger (1970), this population represents a disjunct population of *O. engelmannii* Salm-Dyck var. *cyclodes* Engelm., a taxon in which he includes *O. lindheimeri* var. *chisosensis* Anthony. Cytology and morphology suggest that these plants are closer to *O. lindheimeri* var. *lindheimeri* or to *O. phaeacantha*. In addition, the island mountain habitat and taxonomic characters consistently different from the published description of *O. lindheimeri* var. *lindheimeri* suggest that the diploid *O. lindheimeri* var. *chisosensis* (collections *JFW 228, 289, 291, 294*; Weedin and Powell, 1978*a*) should be treated as a variety distinct from *O. lindheimeri* var. *lindheimeri* (Anthony, 1956; Benson, 1969) or as a distinct species (Ferguson, 1986).

Opuntia phaeacantha Engelm. var *discata* (Griff.) Benson and Walkington. n = 33. Texas, Brewster Co., Alpine, Sul Ross Hill, *JFW 478, 482*; Jeff Davis Co., N of mouth of Musquiz Canyon, *JFW 488*. The mountain slopes adjacent to the Sul Ross State University campus contain an abundance of this variety. In addition, there are several large spineless plants (*JFW 482*) that will occasionally produce a spiny pad typical of *O. phaeacantha* var. *discata*. The origin of spineless pads through hybridization of hexaploid *O. phaeacantha* var. *discata* with spineless octoploid *O. ficus-indica* has been frequently suggested (Benson, 1969, 1982, pers. comm.; McLeod, 1975). However, these spineless plants were found to be meiotically regular hexaploids. *Opuntia ficus-indica* is a cultivar in Trans-Pecos Texas. Therefore, it seems more likely that this intrapopulation variability in *O. phaeacantha* var. *discata* results from other factors (Grant and Grant, 1979, 1980; Bravo-Hollis, 1978; Benson, 1982).

Opuntia phaeacantha Engelm. var. *phaeacantha*. n = 33. Texas, Jeff Davis Co., Ezra's Bedground near Timber Mountain, *JFW 1123*.

Opuntia polyacantha Haw. var. *rufispina* (Engelm. and Bigelow) L. Benson. 2n = 22. Texas, Jeff Davis Co., Madera Canyon, *JFW 1030*. Counts for *O. polyacantha* indicate diploidy for Chihuahuan Desert populations in contrast to tetraploidy and hexaploidy in the Rocky Mountain region (Stockwell, 1935; Pinkava et al., 1977; Weedin and Powell, 1978*a*).

Opuntia polyacantha Haw. var. *trichophora* Coulter. 2n = 22. New Mexico, Guadalupe Co., 12.2 km N of Pastura, *JFW 513*; Texas, Jeff Davis Co., Mount Livermore, *JFW 912*; Presidio Co., near summit of Chinati Peak, *AMP 3109*.

Opuntia rufida Engelm. n = 11. Texas, Brewster Co., BBNP, River Road, Black Dike at Smokey Creek, *JFW 434*.

Opuntia schottii Engelm. var. *schottii*. 2n = 22. Texas, Brewster Co., BBNP, near Boquillas Canyon, *JFW 1152*; 2n = 44. BBNP, junction of Old Ore Road and Ernst Tinaja Road, *DOK 53*. Diploids and tetraploids have been found in populations of *O. schottii* vars. *grahamii* and *schottii* (Weedin and Powell, 1978*a*; Pinkava et al., 1985). These varieties intergrade morphologically in Brewster Co., Texas, and hybridization and chromosome doubling are distinct possibilities.

Opuntia strigil Engelm. var. *strigil*. n = 11. Texas, Pecos Co., 1 km W of Ft. Stockton, *JFW 483*; 2n = 22. 38.4 km S of Ft. Stockton, *JFW 277*; ***n* = 22. 22.4 km E of Ft. Stockton, *AMP 5034*.

**Opuntia tunicata* (Lehm.) Link and Otto *in* Pfeiffer var. *davisii* (Engelm. and Bigelow) L. Benson. 2n = 22. Texas, Presidio Co., SW of Marfa on road to Pinto Canyon, *JFW 856*.

Opuntia aff. *violacea* Engelm. n = 11. Texas, Brewster Co., Hwy. 170, 64 km E of Presidio, *JFW 421*; Presidio Co., Big Hill, ca. 22 km W of Lajitas, *JFW 400*; 2 km W of Big Hill, *JFW 403*. These collections may represent yellow- and yellowish-white-spined forms of *O. violacea* var. *castetteri* L. Benson or an undescribed entity of this complex. *Opuntia violacea* var. *castetteri* is weakly differentiated from *O. violacea* var. *macrocentra* in the Trans-Pecos. Collections *JFW 402* and *AMP 2874* in Weedin and Powell (1978*a*) are *O.* aff. *violacea* rather than *O. lindheimeri*.

Opuntia violacea Engelm. *in* Emory var. *macrocentra* (Engelm.) L. Benson. n = 11. Texas, Brewster Co., 0.8 km S of Study Butte, *JFW 406*; Alpine, Sul Ross Hill, *JFW 481*. Nearly spineless pads of *O. violacea* have been interpreted as *O. violacea* var. *santa-rita* (Griff. and Hare) L. Benson (Benson, 1982). Collection *JFW 481* is nearly spineless but probably represents a form of *O. violacea* var. *macrocentra* (A. Zimmerman, pers. comm.).

Opuntia cf. *violacea* Engelm. *in* Emory var. *violacea*. 2n = 44. Texas, Presidio Co., 1.6 km E of Ruidosa, *JFW 1166*.

Thelocactus bicolor (Galeotti) Britt. and Rose var. *bicolor*. 2n = 22. Texas, Brewster Co., BBNP, W of old McKinney Ranch house, *DOK 56*; Black Hill, SW of Nine Point Mesa, *JFW 408*; BBNP, W end of River Road, *DOK 63*; Presidio Co., ca. 6 km E of Redford, *JFW 1205*.

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Literature Cited

Anthony, M. S. 1956. The Opuntiae of the Big Bend region of Texas. Amer. Midland Nat., 55: 225–256.

Benson, L. 1969. Cactaceae. Pp. 221–317, *in* Flora of Texas (C. L. Lundell and collaborators, eds.). Texas Research Foundation, Renner, 2(2):221–392 + *14 plates*.

———. 1982. The cacti of the United States and Canada. Stanford Univ. Press, Stanford, California.

Bravo-Hollis, H. 1978. Las Cactaceas de México. Second ed. Universidad Nacional Autónoma de México, Ciudad Universitaria, México, D.F., 1:1–743.

FERGUSON, D. 1986. *Opuntia chisosensis* (Anthony) comb. nov. Cactus Succulent J., 58:124–127.

GLASS, C., AND R. FOSTER. 1977. The genus *Thelocactus* in the Chihuahuan Desert. Cactus Succulent J., 49:213–220, 244–251.

GRANT, V., AND K. A. GRANT. 1979. Systematics of the *Opuntia phaeacantha* group in Texas. Bot. Gazette, 140:199–207.

———. 1980. Clonal microspecies of hybrid origin in the *Opuntia lindheimeri* group. Bot. Gazette, 141:101–106.

KOLLE, D. O. 1978. A populational study of *Echinocereus chloranthus* (Cactaceae) in Trans-Pecos Texas. Unpubl. M.S. thesis, Sul Ross State Univ., Alpine, Texas, 79 pp.

LEUCK, E. E. 1980. Biosystematic studies in the *Echinocereus viridiflorus* complex. Unpubl. Ph.D. dissert., Univ. Oklahoma, Norman, 115 pp.

LÖVE, A., AND D. LÖVE. 1982. Reports by A. Löve and D. Löve. Pp. 344–360, *in* IOPB chromosome number reports LXXV (A. Löve, ed.). Taxon, 31:342–368.

MCLEOD, M. G. 1975. A new hybrid fleshy-fruited prickly-pear in California. Madroño, 23:96–98.

MOORE, W. O. 1967. The *Echinocereus enneacanthus-dubius-stramineus* complex (Cactaceae). Brittonia, 19:77–94.

PINKAVA, D. J., AND B. D. PARFITT. 1982. Chromosome numbers in some cacti in western North America—IV. Bull. Torrey Bot. Club, 109:121–128.

PINKAVA, D. J., L. A. MCGILL, T. REEVES, AND M. G. MCLEOD. 1977. Chromosome numbers in some cacti of western North America—III. Bull. Torrey Bot. Club, 104:105–110.

PINKAVA, D. J., M. A. BAKER, B. D. PARFITT, M. W. MOHLENBROCK, AND R. D. WORTHINGTON. 1985. Chromosome numbers in some cacti of western North America—V. Syst. Bot., 10: 471–483.

POWELL, A. M., AND S. A. SLOAN. 1975. Polyploid percentages in gypsum and non-gypsum floras of the Chihuahuan Desert. Sci. Biol. J., 1:37–38.

ROSS, R. 1981. Chromosome counts, cytology, and reproduction in Cactaceae. Amer. J. Bot., 68: 463–470.

STOCKWELL, P. 1935. Chromosome numbers of some of the Cactaceae. Bot. Gazette, 96:565–570.

WEEDIN, J. F., AND A. M. POWELL. 1978*a*. Chromosome numbers in Chihuahuan Desert Cactaceae. Trans-Pecos Texas. Amer. J. Bot., 65:531–537.

———. 1978*b*. Reports by J. F. Weedin and A. M. Powell. Pp. 230–231, *in* IOPB chromosome number reports LX (A. Löve, ed.). Taxon, 27:223–231.

———. 1980. Reports by J. F. Weedin and A. M. Powell. Pp. 716–718, *in* IOPB chromosome number reports LXIX (A. Löve, ed.). Taxon, 29:703–730.

WENIGER, D. 1970. Cacti of the Southwest. Univ. Texas Press, Austin, 249 pp.

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