CHROMOSOME NUMBERS IN CHIHUAHUAN DESERT CACTACEAE. TRANS-PECOS TEXAS[1]

JAMES F. WEEDIN AND A. MICHAEL POWELL
Chihuahuan Desert Research Institute and Department of Biology,
Sul Ross State University, Alpine, Texas 79830

ABSTRACT

Chromosome numbers are presented for 100 collections of Cactaceae from the Trans-Pecos region of Texas. A total of 65 taxa representing 52 species and 12 genera were counted, including first reports for 45 taxa and new ploidy levels for four taxa. Notable among those listed are counts for *Opuntia schottii* var. *grahamii* (n = 11, ca. 22), *O. stanlyi* (n = 22), *O. arenaria* (n = 11), *O. phaeacantha* var. *spinosibacca* (n = 22), *O. lindheimeri* var. *lindheimeri* (n = 11), *O. strigil* (n = 11), *Echinocereus enneacanthus* var. cf. *dubius* (n = ca. 22), *E. pectinatus* var. *neomexicanus* (n = 22), and *Thelocactus bicolor* var. *bicolor* (n = 22). Endomitosis was found to be present in *O. phaeacantha* var. *spinosibacca*, *Mammillaria pottsii*, and *Neolloydia intertexta* var. *dasyacantha*. Meiotic irregularities were noted in some species belonging to the genera *Opuntia* and *Echinocereus*. Phytogeographic considerations are inferred from the chromosomal data for *O. polyacantha*, *O. lindheimeri*, and *O. ficus-indica*. A base number of x = 11 in Cactaceae is supported.

THIS investigation is an initial effort by the authors toward the understanding of certain taxonomic problems in Cactaceae of the Chihuahuan Desert and vicinity. The paper primarily includes chromosome counts from the Trans-Pecos region of Texas, the ecologically variable mountain and desert region west of the Pecos River. Approximately 90 taxa of Cactaceae in 13 genera are found in the Trans-Pecos. Of these 90 taxa, about one-third have a published chromosome number, with the majority of these counts having been obtained from populations outside the Trans-Pecos (Stockwell, 1935; Beard, 1937; Katagiri, 1953; Remski, 1954; Darlington and Wylie, 1955; Spencer, 1955; Anderson, 1960; Fischer, 1962; Moore, 1967; Boke and Anderson, 1970; Pinkava and McLeod, 1971; Pinkava et al., 1973; Conde, 1975; McLeod, 1975; Pinkava et al., 1977). While all of our counts are listed in Table 1, we wish to avoid repetition by commenting only upon those counts which warrant further discussion.

[1] Received for publication 11 October 1977; revision accepted 9 March 1978.

The senior author wishes to thank Dr. B. H. Warnock for introducing him to the study of cacti. Dr. Lyman Benson graciously identified several specimens of *Coryphantha* and discussed problems in cactus taxonomy. Dr. D. J. Pinkava kindly reviewed the manuscript and offered valuable suggestions. Robert Ross discussed various aspects of taxonomy with the senior author and reviewed the manuscript. Don Kolle contributed several counts and provided valuable discussion on numerous occasions. Mike Lockhart, Pete Gober

The use of modern cytological techniques an the documentation of chromosome numbers b vouchers were almost nonexistent in investiga tions of cacti before the papers of Pinkava an McLeod (1971) and Pinkava et al. (1973). Sys tematic studies of Cactaceae are also lacking, bu recent theses represent a beginning toward more natural classification of the cactus famil (i.e., Fischer, 1962; Philbrick, 1963; Walkingtor 1966; McLeod, 1973).

The cactus family (x = 11) is, in general, rep resented by diploid species, although polyploid is common in some genera and ploidy levels t 24x are known in *Mammillaria* (Remski, 195 Sato, 1958; Pinkava et al., 1973). Polyhaploid (haploid of a hexaploid) is reported to occur i *Opuntia oricola* (Philbrick, 1963). Aneuploid (trisomism) and inversions are present in *Opun tia* (Pinkava et al., 1973). Endomitosis is know in *Mammillaria*, *Opuntia*, and *Neolloydia* (Rem ski, 1954; this paper). Cell size is generally large in polyploids as compared to diploids, althoug the size of individual chromsomes generally de creases as the ploidy level increases (Remsk 1954).

MATERIALS AND METHODS—Meiotic count were obtained from pollen mother cells by usin the standard squash techniques of Turner an Johnston (1961). Chromosome staining was ac complished with acetocarmine or alcohol HC

cussion on numerous occasions. Mike Lockhart, Pete Sloan and Clark Champie were instrumental in securing certain collections. We are grateful to the National Park Service for granting a permit to collect in Big Bend National Park. NSF Grant DEB77-07559 is acknowledged for partial field support.

complished with acetocarmine or alcohol-HC carmine. Mitotic counts were made from youn root tips which were treated in saturated para dichlorobenzene for approximately two hour

TABLE 1. *Species of Cactaceae examined for chromosome number*

Species	*n* Number	Locality and Voucher
**Opuntia tunicata* (Lehm.) Link & Otto var. *tunicata*	11[a]	Brewster Co. Leonard Mountain, *G. Lazar and . Klar* s.n.
O. imbricata (Haw.) DC. var. *imbricata*	11[a]	Brewster Co. ca. 3.2 km W of Iron Mountain, *JI 308.*
**O. imbricata* (Haw.) DC. var. *argentea* Anthony	11[a]	Brewster Co. near Mariscal Mine, BBNP, *JFW, and S. E. Bell 205.*
O. leptocaulis DC.	22[a]	Pecos Co. near Hovey, *AMP 3054.*
O. kleiniae DC. var. *kleiniae*	ca. 22[a]	Jeff Davis Co. 0.6 km E of Mitre Peak, *JFW 300*
O. kleiniae DC. var. *kleiniae*	ca. 22[b]	Jeff Davis Co. 1 km E of Mitre Peak, *JFW 299*; km E of Mitre Peak, *JFW 301.*
**O. schottii* Engelm. var. *grahamii* (Engelm.) L. Benson	11	Brewster Co. 15 km N of Study Butte, *AMP 307*
***O. schottii* Engelm. var. *grahamii* (Engelm.) L. Benson	ca. 22[a]	Brewster Co. Old Ore Road near La Noria, BBN *JFW and TJW 237.*
**O. stanlyi* Engelm.	22[a]	Presidio Co. 8 km NW of Candelaria, *DOK 9.*
**O. polyacantha* Haw. var. *rufispina* (Engelm. & Bigelow) L. Benson	11[a]	Jeff Davis Co. N side of Sawtooth Mountain, *JF and J. M. Lockhart 112.* Hudspeth Co. ca. 20.1 k of Dell City, *AMP, SAP, and JFW 2833.*
**O. polyacantha* Haw. var. *trichophora* Coulter	11[a]	Hudspeth Co. ca. 8 km E of Hueco Pass, *JFW a DOK 473.*
**O. arenaria* Engelm.	11[a]	El Paso Co. near Anthony. *C. Champie* s.n.
O. rufida Engelm.	11[a]	Presidio Co. Chorro Canyon, *JFW 26*; middle Colorado Canyon, *JFW 109.*
O. macrorhiza Engelm. var. *macrorhiza*	ca. 22	Brewster Co. lower Sul Ross Hill, Alpine, *JFW*
**O. macrorhiza* Engelm. var. *pottsii* (Salm-Dyck) L. Benson	22[a]	Brewster Co. lower Sul Ross Hill, Alpine, *JFW*
**O. atrispina* Griffiths	33	Brewster Co. Hot Springs, BBNP, *JFW 462.*
O. atrispina Griffiths	ca. 33[a]	Brewster Co. 7.5 km E of Panther Junction, BBI *JFW 363.*
O. violacea Engelm. var. *santa-rita* (Griffiths & Hare) L. Benson	11[a]	Brewster Co. Sul Ross Hill, Alpine, *JFW 318.*
**O. violacea* Engelm. var. *macrocentra* (Engelm.) L. Benson	11[a]	Brewster Co. 0.5 km S of Study Butte, *JFW 364*
**O. violacea* Engelm. var. *castetteri* L. Benson	11[a]	Brewster Co. ca. 63 km S of Alpine, *JFW 459.*
**O. phaeacantha* Engelm. var. *spinosibacca* (Anthony) L. Benson	22	Brewster Co. Hot Springs, BBNP. *DOK and JF*
O. phaeacantha Engelm. var. *spinosibacca* (Anthony) L. Benson	ca. 22[a,c]	Brewster Co. Hot Springs, BBNP, *JFW 286.*
O. phaeacantha Engelm. var. *major* Engelm.	33	Brewster Co. near old McKinney Ranch House, Ore Road, BBNP, *AMP, SAP, and JFW 2882.*

		Presidio Co. 29 km E of Redford, *JFW 453*.
O. phaeacantha Engelm. var. *major* Engelm.	ca. 33[a]	Brewster Co. lower Green Gulch, Chisos Mounta BBNP, *JFW 374*.
O. phaeacantha Engelm. var. *discata* (Griffiths) Benson & Walkington	ca. 33[a]	Brewster Co. Tornillo Flats, BBNP, *JFW 118*.

TABLE 1. *Continued*

Species	*n* Number	Locality and Voucher
***O. lindheimeri* Engelm. var. *lindheimeri*	11	Brewster Co. near trailhead to Emory Peak, Chisos Mountains, BBNP, *JFW 289*; near Emory Peak, Chisos Mountains, BBNP, *JFW 294*. Presidio Co. I Hill between Redford and Lajitas, *JFW and DOK 4*
O. lindheimeri Engelm. var. *lindheimeri*	11[a]	Brewster Co. near summit of Emory Peak, Chisos Mountains, BBNP, *JFW 291*; upper Green Gulch, Chisos Mountains, BBNP, *JFW 228*. Presidio Co. I Hill between Redford and Lajitas, *AMP, SAP, and JFW 2874*.
O. cf. *lindheimeri* Engelm. var. *lindheimeri*	ca. 33[a]	Brewster Co. East Bourland Mountain, *JFW and T 193*.
**O. lindheimeri* Engelm. var. *linguiformis* (Griffiths) L. Benson	33[d]	Brewster Co. Sul Ross campus, Alpine, *JFW 298*.
**O. strigil* Engelm.	11[a]	Terrell Co. 4.3 km E of Dryden, *JFW 143*. Pecos C ca. 1.6 km W of Fort Stockton, *JFW 279*.
O. ficus-indica Mill.	11	Brewster Co. Sul Ross campus, Alpine, *JFW 303a*.
**Cereus greggii* Engelm. var. *greggii*	11[a]	Pecos Co. N of Hovey, *AMP, SAP, and JFW 2985*
Echinocereus triglochidiatus Engelm. var. *melanacanthus* (Engelm.) L. Benson	22[e]	Presidio Co. near mouth of Chorro Canyon, *JFW 2*
E. triglochidiatus Engelm. var. *melanacanthus* (Engelm.) L. Benson	22[a]	Hudspeth Co. ca. 8 km W of Indian Hot Springs, *JFW 259*.
**E. triglochidiatus* Engelm. var. *neomexicanus* (Standl.) Standl. ex W. T. Marshall	ca. 22[a]	Brewster Co. upper Green Gulch, Chisos Mountain BBNP, *JFW 225*.
**E. triglochidiatus* Engelm. var. *gurneyi* L. Benson	22[a]	Brewster Co. just S of East Bourland Mountain, *JF and TJW 190*.
**E. triglochidiatus* Engelm. var. *paucispinus* Engelm. ex W. T. Marshall	22[a]	Val Verde Co. Pecos River crossing, ca. 40.2 km N Langtry, *AMP, SAP, and JFW 2964b*.
**E. fendleri* (Engelm.) Engelm. ex Rümpler var. *fendleri*	11[a]	El Paso Co. Fusselman Canyon, Franklin Mts., *DO and B. H. Warnock 81*.
E. enneacanthus Engelm. var. *brevispinus* (W. O. Moore) L. Benson	11[a]	Val Verde Co. Pecos River crossing, ca. 40.2 km N Langtry, *AMP, SAP, and JFW 2964a*.
E. enneacanthus Engelm. var. *dubius* (Engelm.) L. Benson	11	Brewster Co. Johnson Ranch House, River Road, BBNP, *JFW and TJW 429*.
***E. enneacanthus* Engelm. var. cf. *dubius* (Engelm.) L. Benson	ca. 22[a]	Hudspeth Co. ca. 8 km W of Indian Hot Springs, *JFW 258*.
**E. lloydii* Britton & Rose	22	Pecos Co. near Tunis Springs, *DOK 45*.
**E. pectinatus* (Scheidw.) Engelm. var. *neomexicanus* (Coulter) L. Benson	22[f]	Brewster Co. Mariscal Mine, BBNP, *JFW, TJW, a S. E. Bell 204*; ca. 5.6 km SE of Mail Box Tank, Ol Ore Road, BBNP, *JFW and TJW 249*.
**E. reichenbachii* (Terscheck) Haage f. var. *chisosensis* (W. T. Marshall) L. Benson	11[a]	Brewster Co. E of Dugout Wells, BBNP, *JFW 21*.

NEXT

**E. viridiflorus* Engelm. var. *davisii* (A. D. Houghton) W. T. Marshall	11[a]	Brewster Co. S of Marathon, *G. Lazar and A. Kia* s.n.
E. viridiflorus Engelm. var. *cylindricus* (Engelm.) Engelm. ex Rümpler	11	Brewster Co. 8 km S of Alpine, *JFW 47*; near Hes Canyon, Glass Mountains, *JFW 156*; ca. 30 km S o Alpine, *JFW and K. D. Perry 211*.

Species	*n* Number	Locality and Voucher
E. viridiflorus Engelm. var. *cylindricus* (Engelm.) Engelm. ex Rümpler	11[a]	Presidio Co. Love Ranch, S of Marfa, *JFW and J. Lockhart 119*. Brewster Co. near Hess Canyon, Gl Mountains, *JFW 188*.
**E. chloranthus* (Engelm.) Engelm. ex Rümpler	11	Brewster Co. ca. 4.8 km N of old McKinney Ranc House, Old Ore Road, BBNP, *JFW 20*; East Bour Mountain, *JFW and TJW 191*.
Mammillaria heyderi Mühlenpfordt var. *heyderi*	11[a]	Brewster Co. near middle Tornillo Creek, BBNP, *JFW 114*.
**M. heyderi* Mühlenpfordt var. *meiacantha* L. Benson	11[a]	Presidio Co. middle of the Solitario, *AMP 2818*.
**M. prolifera* (Miller) Haw. var. *texana* (Poselger) Borg	22[a]	Kerr Co. several km E of Kerrvile, *B. Buck* s.n.
**M. lasiacantha* Engelm.	11	Brewster Co. Dead Horse Mountains, BBNP, *JFV* s.n.
**M. pottsii* Scheer	11[a]	Brewster Co. Left-Hand Shut-up, Solitario, *JFW 8*
M. pottsii Scheer	11[a,c]	Presidio Co. near old Smith Ranch House, *JFW 9*
**M. grahamii* Engelm.	11[a]	El Paso Co. Fusselman Canyon, Franklin Mts., *D and B. H. Warnock 80*.
Ferocactus hamatacanthus (Mühlenpfordt) Britton & Rose var. *hamatacanthus*	11[a]	Pecos Co. near Tunis Springs, *TJW 12*.
**F. setispinus* (Engelm.) L. Benson	11[a]	Travis Co. 32 km E of Austin, *B. Buck* s.n.
Echinocactus horizonthalonius Lemaire	11[a]	Brewster Co. ca. 1.6 km W of Ernst Tinaja, Old O Road, BBNP, *JFW and TJW 240*.
E. texensis Hoppfer	11[a]	Brewster Co. Tornillo Flats, BBNP, *JFW and TJV 152*.
**Epithelantha micromeris* (Engelm.) Weber ex Britton & Rose	11[a]	Presidio Co. near Lower Shut-Up, Solitario, *JFW*
**E. bokei* L. Benson	11	Brewster Co. ca. 12.8 km W of Hen Egg Mountair *DOK 1*.
**Thelocactus bicolor* (Galeotti) Britton & Rose var. *bicolor*	11[a]	Presidio Co. near old Smith Ranch House, *JFW 8*
***T. bicolor* (Galeotti) Britton & Rose var. *bicolor*	22[a]	Brewster Co. Left-Hand Shut-Up, Solitario, *JFW*
**T. bicolor* (Galeotti) Britton & Rose var. *flavidispinus* Backeberg	11[a]	Brewster Co. East Bourland Mountain, *JFW and 192*.
**Neolloydia conoidea* (DC.) Britton & Rose	11[a]	Brewster Co. 46.6 km S of Marathon, *JFW 10*.
**N. warnockii* L. Benson	11	Brewster Co. middle Tornillo Creek, BBNP, *JFW 115*.
**N. mariposensis* (Hester) L. Benson	11[a]	Brewster Co. 11.2 km S of old McKinney Ranch House, Old Ore Road, BBNP, *JFW 18*.
**N. intertexta* (Engelm.) L. Benson var. *intertexta*	11	Brewster Co. ca. 30 km S of Alpine, *TJW* s.n.
**N. intertexta* (Engelm.) L. Benson var. *dasyacantha* (Engelm.) L. Benson	11[a,b]	Hudspeth Co. 32.2 km W of Indian Hot Springs, *J and TJW 269*.
**Ancistrocactus scheeri* (Salm-Dyck) Britton & Rose	11[a]	Zapata Co. Falcon Lake, *D. E. Deal* s.n.

. M.
lass NEXT

h
land

V

2.
3.
OK

re

V

86.

1.

).

80.

TJW

FW

A. uncinatus (Galeotti) L. Benson var. *wrightii* (Engelm.) L. Benson	11	Presidio Co. just E of old Smith Ranch House, *JF 83*; near mouth of Chorro Canyon, *JFW 29*.
**Coryphantha macromeris* (Engelm.) Britton & Rose var. *macromeris*	11[a]	Brewster Co. Tornillo Flats, BBNP, *JFW 113*.

C. strobiliformis (Poselger) Orcutt var. *strobiliformis*	11	Brewster Co. Cox Ranch, N of Marathon, *DOK 2*.
C. strobiliformis (Poselger) Orcutt var. *strobiliformis*	11[a]	Brewster Co. 11.2 km S of old McKinney Ranch House, Old Ore Road, BBNP, *JFW 19*; ca. 5.6 km E of Banta Shut-In, Old Ore Road, BBNP, *JFW and TJW 242*; Left-Hand Shut-Up, Solitario, *JFW 81*.
**C. dasyacantha* (Engelm.) Orcutt var. *dasyacantha*	11[a]	Brewster Co. ca. 0.8 km S of Iron Mountain, *JFW 196*; ca. 1.6 km W of Iron Mountain, *JFW and TJW 304*.
Ariocarpus fissuratus (Engelm.) K. Schum. var. *fissuratus*	11[a]	Presidio Co. just NW of Shafter, *AMP 2819*. Brewst Co. near Fizzle Flats, *TJW 1*.

* Indicates unreported taxon.
** Indicates new ploidy level for taxon.
[a] Chromosome number derived from somatic root tip count.
[b] Reported as n = ca. 22 because meiotic configurations were very irregular with various combinations as multivalent especially rings of four.
[c] In a single root tip, 12 cells showed a count of $2n$ = ca. 44, 2 cells were counted as $2n$ = ca. 55, and one cell was count as $2n$ = ca. 77. Two additional root tips produced similar results.
[d] Indicates two to five univalents observed in most cells and occasionally a possible trivalent.
[e] Numerous possible multivalents common in meiotic cells with one or more rings of four.
[f] Denotes consistent multivalent formation with both trivalents and rings of four.
[g] In a single root tip, a total of 15 cells were observed with slightly more $4n$ ($2n$ = ca. 44) cells than $2n$ ($2n$ = 22) cells
[h] A squash of two root tips revealed three cells with $2n$ = 44 among numerous $2n$ = 22 cells. These tetraploid cells we noticeably larger than the diploid cells.

and killed and fixed in chloroform-absolute ethanol-glacial acetic acid (1:3:1). The root tips were squashed in warm acetoorcein or alcohol-HCl-carmine.

Vouchers are deposited in the herbarium of Sul Ross State University (SRSU). Nomenclature follows that of Benson (1969) and Glass and Foster (1977). Identifications are those of the senior author. While some collections listed in Table 1 were obtained from localities east of the Pecos River, they represent species whose ranges extend into the Chihuahuan Desert. The following abbreviations are used for principal collectors and localities: *JFW* (James F. Weedin), *TJW* (Teresa J. Weedin), *AMP* (A. Michael Powell), *SAP* (Shirley A. Powell), *DOK* (Donald O. Kolle), and BBNP (Big Bend National Park).

RESULTS AND DISCUSSION—*Opuntia*—Based upon three chromosome counts of $2n$ = 33, Fischer (1962) reported the occurrence of probable hybrids between *Opuntia kleiniae* and *O. leptocaulis* in the Trans-Pecos. Using morphological data, Anthony (1956) also reported possible hybrids between the two species. Our chromosomal examinations of these species (Table have so far shown them to be tetraploid. Cyt logical evidence of hybridization, such as th reported by Fischer (1962), would require at lea one parent to be diploid. *Opuntia kleiniae* and *leptocaulis* occur sympatrically in localized po ulations throughout the Trans-Pecos, and th the opportunity for hybridization is present. Th discovery of a diploid population of *O. leptoca lis* in Arizona (Pinkava et al., 1977) adds feas bility to a possible triploid hybrid between *kleiniae* and *O. leptocaulis*.

Our reports for *Opuntia schottii* var. *graham* (n = 11, ca. 22) and *O. stanlyi* (n = 22) are a parently first counts for the section *Corynopu tia*. The two varieties of *O. schottii* (var. *schot* and var. *grahamii*) are known to intergrade the Trans-Pecos (Benson, 1969). It may be th our tetraploid count for var. *grahamii* reflec hybridization and chromosome doubling, b more extensive studies are needed for confi mation.

Stockwell (1935) reported tetraploid counts f *O. polyacantha* from Colorado, Saskatchewa and southern Alberta and a hexaploid count fro

Peace River in northern Alberta. The diploid counts presented in Table 1 for var. *rufispina* represent populations in two distinct habitats at the southern range of the species. The Jeff Davis Co. collection (Table 1) was obtained from igneous soil at an elevation of 1,900 m, while the Hudspeth Co. collection was obtained at a lower elevation (1,100 m) in gypseous soils. The entire *O. polyacantha* complex seems to represent a latitudinal cline with an increase in ploidy level corresponding to more northerly latitudes.

The counts for *Opuntia violacea* (Table 1) further establish the dominance of diploid taxa in this species. Only *O. violacea* var. *violacea* is known to be tetraploid in Arizona and New Mexico (Pinkava and McLeod, 1971; Pinkava et al., 1973).

Endomitosis was found to occur in *Opuntia phaeacantha* var. *spinosibacca*. Root tips from a single joint showed a majority of cells to be tetraploid (Table 1), although pentaploid and heptaploid cells were also present. Our count for this taxon ($n = 22$) is interesting in that the *O. phaeacantha* complex is generally considered hexaploid. Further mitotic and meiotic data may help clarify the taxonomic position of this taxon.

Opuntia lindheimeri var. *lindheimeri* is represented in the Trans-Pecos by both diploid and hexaploid populations (Table 1). Although hexaploid populations most likely cover a larger geographical area, a diploid population (Table 1) is present in the higher Chisos Mountains in Big Bend National Park at elevations of 1,585–2,380 m. Hexaploid populations are most commonly found below 1,200 m elevation. Anthony (1954, 1956) documents what we presume are diploid plants at slightly lower elevations of the Chisos Mountains, but along streams that drain from the upper mountainous slopes. We also found one population from Presidio Co. (Table 1) to be diploid, at an approximate elevation of 1,000 m, but again in mountainous terrain. A more intensive investigation is underway to determine the taxonomic significance of these diploid populations.

Opuntia ficus-indica is represented in the Trans-Pecos as a spineless cultivar. Our diploid count (Table 1) is unreported in North America. Previously, several octoploid counts of the spineless form were known from Arizona and California, while the spiny form is also octoploid in California (Pinkava and McLeod, 1971; Pinkava et al., 1973; McLeod, 1975). A diploid

vious count for the species which was from Arizona population (Pinkava and McLe 1971).

Echinocereus—Four varieties of *Echinocer triglochidiatus* are known in the Trans-Pe (Benson, 1969). Our tetraploid counts (Tabl for all four taxa reinforce the first tetraploid port for the species (Pinkava et al., 1973). A cent diploid report for *E. triglochidiatus gonacanthus* from Colorado has added to the tological complexity of this species (Pinkav al., 1977).

Large and diverse populations of the *Ech çereus enneacanthus* complex are found in Trans-Pecos. Previous counts by Beard (1 and Moore (1967) have characterized the er complex as diploid. One collection of *E. en canthus* var. cf. *dubius* was found to be te ploid (Table 1) in all cells of four root tips dicating that this species is more comp cytologically than was previously believed.

The species *Echinocereus lloydii* and *E. tinatus* are reported (Table 1) for the first ti Along with *E. engelmannii*, *E. triglochidia* and *E. enneacanthus*, these species represent fourth and fifth polyploid species of *Echin reus* (Pinkava et al., 1973; this paper). A dip count is also known for a variety of *E. pectin* from Mexico (D. J. Pinkava, personal com nication). It should be noted that only abou of the 20 to 30 species of *Echinocereus* have b counted.

Echinocereus reichenbachii var. *chisosens* the only variety of this species in the Trans cos. Our diploid count (Table 1) is supporte diploid counts for all varieties of *E. reichenba* (Robert Ross, personal communication).

The counts in Table 1 for *Echinocereus ch anthus* ($n = 11$) are first reports for the spec Future work may reveal several taxa within species. One collection, *JFW 20*, would co spond to what has been called *E. russan* while the other collection, *JFW and TJW 19* sometimes referred to as *E. chloranthus neocapillus* (Weniger, 1969).

Mammillaria—The published report (St well, 1935) of $2n = 18$ for *M. heyderi* var. *hey* ($2n = 22$; Table 1) has never been confirmed is probably in error.

count has been reported from Puerto Rico (Spencer, 1955) and another octoploid count is known from South America (Darlington and Wylie, 1955).

A single plant of *Mammillaria pottsii* (*JFW* contained both diploid and tetraploid cells in same root tip (Table 1). The plant in which domitosis occurred is somewhat unusual for species in that the stem is over 20 cm long

'93)
the
en-
this

and has been previously reported in *Mammillaria* (Remski, 1954).

Epithelantha—*Epithelantha micromeris* and *E. bokei* (Table 1) are both previously unreported in the literature. However, a diploid count has been obtained for *E. bokei* by Robert Ross (personal communication).

Thelocactus—The one previous count for *Thelocactus bicolor* (Beard, 1937) agrees with the diploid counts (Table 1) for the two varieties which occur in the Trans-Pecos. A second collection of *T. bicolor* var. *bicolor* (Table 1) showed a tetraploid count from several root tips.

Neolloydia—All five previously unreported taxa of *Neolloydia* that occur in the Trans-Pecos were counted as diploids (Table 1). Root tips of one collection (*JFW and TJW 269*) contained three tetraploid cells among a vast majority of diploid cells.

Coryphantha—*Coryphantha scheeri* var. *valida* ($2n = 22$) was counted from populations at lower elevations (1,100 m) in gypseous soils (*AMP* et al. *2830*) and at higher elevations (ca. 1,900 m) in igneous soils (*AMP 2820*). A diploid count for *Coryphantha cornifera* var. *echinus* (Table 1) has also been obtained by Robert Ross (personal communication).

Escobaria—In a recent paper (Castetter, Prince, and Schwerin, 1975) *Escobaria* was maintained as a genus separate from *Coryphantha*. If this disposition is followed, eight taxa including *Coryphantha strobiliformis* var. *strobiliformis* and *C. dasyacantha* var. *dasyacantha* (Table 1) would belong to *Escobaria*. Three diploid counts of *Coryphantha strobiliformis* var. *strobiliformis* (*JFW 19*, *JFW 81*, and *JFW and TJW 242*) are known to some authors as *Escobaria albocolumnaria* (Castetter et al., 1975). Since known counts are diploid in all cases, the chromosome number itself is of no help in distinguishing the two as genera.

LITERATURE CITED

ANDERSON, E. F. 1960. A revision of *Ariocarpus* (Cactaceae). I. The status of the proposed genus *Roseocactus*. Amer. J. Bot. 47: 582–589.

ANTHONY, M. S. 1954. Ecology of the Opuntiae in the Big Bend region of Texas. Ecology 35: 334–347.

BENSON, L. 1969. Cactaceae. *In* C. L. Lundell and coll orators. Flora of Texas, vol. 2, pt. II. Renner: Te Research Foundation.

BOKE, N. H., AND E. F. ANDERSON. 1970. Structure, velopment, and taxonomy in the genus *Lophopho* Amer. J. Bot. 57: 569–578.

CASTETTER, E. F., P. PRINCE, AND D. H. SCHWER 1975. A reassessment of the genus *Escobaria*. Cac Succulent J. 47: 60–70.

CONDE, L. F. 1975. Anatomical comparisons of five spec of *Opuntia* (Cactaceae). Ann. Mo. Bot. Gard. 62: 4 473.

DARLINGTON, C. D., AND A. P. WYLIE 1955. Chromoso atlas of flowering plants, p. 101–105. G. Allen and Un Ltd., London.

FISCHER, P. 1962. Taxonomic relationships of *Opuntia k niae* DeCandolle and *Opuntia tetracantha* Tourn M.S. thesis. Univ. of Arizona, Tucson.

GLASS, C., AND R. FOSTER. 1977. The genus *Thelocac* in the Chihuahuan Desert. Cactus Succulent J. 49: 2 220, 244–251.

KATAGIRI, S. 1953. Chromosome numbers and polyplo in certain Cactaceae. Cactus Succulent J. 25: 141–1

MCLEOD, M. G. 1973. Biosystematics of juicy-fruited pri ly-pears of Arizona (Cactaceae: *Opuntia* series Op tiae). Ph.D. dissertation. Arizona State Univ., Tem

———. 1975. A new hybrid fleshy-fruited prickly-pear California. Madroño 23: 96–98.

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

PHILBRICK, R. N. 1963. Biosystematic studies of two Pac coast Opuntias. Ph.D. dissertation. Cornell Univ., aca, New York.

PINKAVA, D. J., AND M. G. MCLEOD. 1971. Chromoso numbers in some cacti of western North America. B tonia 23: 171–176.

———, ———, L. A. MCGILL, AND R. C. BROWN. 19 Chromosome numbers in some cacti of western Nc America. II. Brittonia 25: 2–9.

———, L. A. MCGILL, T. REEVES, AND M. G. MCLE 1977. Chromosome numbers in some cacti of west North America. III. Bull. Torrey Bot. Club 104: 110.

REMSKI, M. F. 1954. Cytological investigations in *Mam laria* and some associated genera. Bot. Gaz. 116: 171.

SATO, D. 1958. Chromosome of the Cactaceae. Succ. J 3: 88–91.

SPENCER, J. L. 1955. A cytological study of the Cactac of Puerto Rico. Bot. Gaz. 117: 33–37.

STEBBINS, G. L. 1971. Chromosomal evolution in hig plants. Addison-Wesley, London.

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

TURNER, B. L., AND M. C. JOHNSTON. 1961. Chromoso numbers in the Compositae. III. Certain Mexican s cies. Brittonia 13: 64–69.

WALKINGTON, D. L. 1966. Morphological and chemical dence for hybridization in some species of *Opuntia* curring in southern California. Ph.D. dissertation. Ch

Bend region of Texas. Ecology 35: 334–347.
———. 1956. The Opuntiae of the Big Bend region of Texas. Amer. Midl. Nat. 55: 225–256.
BEARD, E. C. 1937. Some chromosome complements in the Cactaceae and a study of meiosis in *Echinocereus papillosus*. Bot. Gaz. 99: 1–21.
cutting in southern California. Ph.D. dissertation. Cl mont Graduate School and Univ. Center, Claremo California.
WENIGER, D. 1969. The small-flowered echinocerei of Te and New Mexico. Cactus Succulent J. 41: 34–43.