

Current Knowledge and Conservation of *Cylindropuntia multigeniculata* (Cactaceae), the Blue Diamond cholla

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SUMMARY: The typical form of the Blue Diamond cholla, *Cylindropuntia multigeniculata*, is now known to occur from north of Las Vegas, near Gass Peak, in the Las Vegas Range, southwest into the La Madre Mountain area, south to Blue Diamond, and then southeast into the McCullough Range. The knowledge of new localities is largely owing to efforts of Gina Glenne of the U.S. Fish & Wildlife Service, and Pat Putnam and Jed Botsford of the Bureau of Land Management. Prior to these discoveries, the Blue Diamond cholla was known to occur only at its type locality in the Blue Diamond Hills, just west of Las Vegas. Current surveys indicate that populations of *C. multigeniculata* conservatively occupy at least 25km² with densities averaging 23 individuals per hectare, thus the conservative estimate of number of individuals is 56,500. This estimate does not include at least one population in the Sheep Range that appear to be comprised of individuals morphologically intermediate between *C. multigeniculata* and *C. whipplei* var. *whipplei*. Populations of *C. multigeniculata* with consistently spiny fruits occur from Bonelli Peak, Gold Butte area of eastern Clark County, Nevada, south into the White Hills and Black Mountains of Mojave County, Arizona. Individuals occupy a similar amount of area to that of the more typical form with slightly higher overall densities. All but one population of *C. multigeniculata* appear healthy and free of immediate threats. At least a portion of the Blue Diamond Population, which the type locality for *C. multigeniculata*, is threatened by development. It is herein recommended that the status of *C. multigeniculata* remain a species of concern and that it not be listed as threatened or endangered by the U. S. Fish & Wildlife Service.

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I. Classification and Systematics

Scientific Name: *Cylindropuntia multigeniculata* (Clokey) Backeberg, *Cactaceae* 1: 186. 1958.

Type Specimens: ISOTYPE: Nevada, Clark Co., "Rocky ridge east of Wilson's Ranch...from Blue Diamond mine to mill", Charleston [Spring] Mountains, 1400 meters, 13 July 1939, Clokey 8430 (DS! (photo ASU!), MICH!, POM!, MO! (photo ASU!), US!, NY!, ARIZ!, TEX!, MEXU! (photos ASU!)). (Benson (1969) erroneously designated as lectotype Clokey 8630 (UC) from same locality for "so long as the type is missing")

Synonyms: *Opuntia multigeniculata* Clokey, *Madrono* 7: 69. pl. 4, fig. A. 1943;
Opuntia whipplei var. *multigeniculata* L. Benson, *Cacti Ariz.* ed. 3 20. 38. 1969

Vernacular Names: Blue Diamond cholla

Family: Cactaceae (cactus family); Subfamily: Opuntioideae

Major groups of higher classification hierarchy for Cactaceae

	Cronquist (1988)	Thorne (1992)
Class	Magnoliopsida (Dicotyledoneae)	Magnoliopsida (Angiospermae)
Subclass	Caryophyllidae	Caryophyllidae
Superorder	none	Caryophyllanae
Order	Caryophyllales	Caryophyllales
Suborder	none	Cactineae

Review of Alternative Taxonomic Treatments:

Cylindropuntia multigeniculata (Clokey) Backeberg was originally described as *Opuntia multigeniculata* Clokey (Clokey 1943). The type locality occurs just north of the town of Blue Diamond, Nevada.

Benson (1985) places *C. multigeniculata* as a variety under what is now *C. whipplei* (Engelm. & J. M. Bigelow) Knuth [= *Opuntia whipplei* Engelm. & J. M. Bigelow]. He also places *C. abyssi* Hester as a synonym of *O. whipplei* var. *multigeniculata*. Trushell (1985) regards *C. abyssi* (*C. × abyssi*) as a hybrid between *C. acanthocarpa* (Engelm. & Bigelow) F. M. Knuth and *C. bigelovii* (Engelm.) F. M. Knuth and excludes it from *C. whipplei*.

Pinkava (1999) regards *C. abyssi* as a good species that may be of hybrid origin (unknown parentage) and reports that its geographic distribution is limited to its type locality in Peach Springs Canyon, just north of Peach Springs, Mohave County, Arizona (1440-3120ft elevation). Individuals number at least a few hundred or, at most, a few thousand, and occur primarily on limestone hillsides. A few individuals occur along the

canyon bottom and are visible from the road.

Based on morphological intermediacy of certain characters, Pinkava (1999) regards *C. multigeniculata* (*C. × multigeniculata*) as a hybrid between *C. echinocarpa* (Engelm. & J. M. Bigelow) Knuth and *C. whipplei*. In contrast, Trushell (1985) suggests that this apparent intermediacy is superficial because *C. multigeniculata* possesses morphological characteristics that are not intermediate between the two putative parents. She reports that individuals of *C. multigeniculata* are morphologically distinguishable from those of the putative *C. echinocarpa* × *C. whipplei* hybrids. Compared to putative hybrid individuals, those of *C. multigeniculata* possess shorter, more densely crowded stem segments, a greater number of radial and central spines, a greater tubercle height, greater areole length, and shorter fruit length. She further postulated that some of the morphology of *C. multigeniculata* could be attributable to another possible parent, *C. bigelovii* and that characteristics shared between *C. bigelovii* and *C. multigeniculata* include habitat preference, habit, tubercle length versus width, stem segment width versus length, and fruit shape, spinelessness, color, and persistence on the plant.

Baker (2002) agrees with Trushell's findings except that he suggests that *C. multigeniculata* is closely related to *C. whipplei*. His findings are based on additional morphological and geographical information. Pinkava's (1999) hybrid hypothesis is based on the resemblance of *C. multigeniculata* to populations of spiny-fruited cholla northwest of Kingman, Arizona. Because of the spiny fruits, this population was identified by Pinkava and others as *C. echinocarpa*. Baker (in prep.) circumscribes this population under *C. multigeniculata* and has shown that populations of this taxon are more closely related in their morphology to *C. multigeniculata* than to *C. echinocarpa*. Furthermore, there are no recorded hybrids of spiny-fruited form of *C. multigeniculata* with either *C. echinocarpa* or with *C. whipplei*. In fact, the regional populations of *C. whipplei* are tetraploid (Trushell 1985, Baker in prep.) and would therefore spawn triploids or, if doubling occurred, higher polyploids with the diploid *C. echinocarpa* or the diploid *C. multigeniculata* (Baker in prep.). To date, there have been no reports of hybridization between *C. echinocarpa* and *C. multigeniculata*, even though the two co-occur in at least four localities. Within populations of both forms of *C. multigeniculata*, however, individuals have been recorded with morphology intermediate to the more distantly related *C. acanthocarpa* var. *coloradensis* (Clokey 1943 & Baker in prep.). These individuals are generally more yellow in spine and spine sheath color, as in *C. acanthocarpa* var. *coloradensis*; possess longer stems and stem tubercles than *C. multigeniculata* but shorter than those of *C. acanthocarpa* var. *coloradensis*; possess a habit that is less densely-stemmed than in *C. multigeniculata* but less open as in *C. acanthocarpa* var. *coloradensis*, and flowers that are larger than those of *C. multigeniculata*, with orange-tinged tepals and purple-tinged stamen filaments like those of *C. acanthocarpa* var. *coloradensis*.

A population near Joe May Canyon, Sheep Range, Nevada, appears to be comprised of individuals morphologically intermediate between *C. multigeniculata* and *C. whipplei* var. *whipplei*. Morphological intermediacy between two or even among three or more

species, however, is commonplace within *Cylindropuntia* (see under Biography and Phylogeny below). The remaining populations of *C. multigeniculata* are morphologically distinct, and possess their own geographic and ecological distribution (Baker in prep.).

Biogeography and Phylogeny:

Cylindropuntia is a genus of approximately 50 species, most of which occur in Mexico and the United States. A few clonal species occur as weeds in the Caribbean, Venezuela, Ecuador, Chile, and even some areas of the Old World. All species occur in arid or semi-arid regions with annual precipitation of approximately 50cm or less and minimum temperatures of above 0° F. Soils and topography vary widely both within and among species. The genus is confusing taxonomically because of polyploidy and hybridization. The number of putative hybrid taxa far exceeds the number of recognized non-hybrid species. In the greater Southwest, for example, *C. acanthocarpa* is thought to hybridize with *C. abyssii*, *C. bigelovii*, *C. fulgida*, *C. echinocarpa*, *C. leptocaulis*, *C. spinosior*, *C. versicolor*, and diploid *C. whipplei*. In addition, *C. echinocarpa* is thought to hybridize with *C. californica*; *C. leptocaulis* and diploid *C. whipplei*; *C. fulgida* with *C. leptocaulis* and *C. spinosior*; *C. spinosior* with *C. leptocaulis* and *C. versicolor*; and *C. whipplei* with *C. leptocaulis*. Several other putative hybrids occur that have disputed or, simply unknown, parentage. Some interspecific hybrids in *Cylindropuntia* are abundant and geographically widespread. For example, in the region where Arizona, Nevada, and California meet, *C. ×deserta* is more common in some areas than either of its putative parents, *C. acanthocarpa* and *C. echinocarpa*.

II. Taxon history

1939: First collection, Clokey, 13 July, at Blue Diamond Hill. Benson (1982) lectotypified *Opuntia multigeniculata* with the following specimen: Clokey 8630, east of Wilson's Ranch, Blue Diamond Mill to the Mind, 1400m elevation, Charleston Mountains, Clark Co. Nevada, UC (box) 872689. Benson gives a list of duplicates for the type. Although he also has a list of additional locations for the species, he does not differentiate between those for *C. multigeniculata* and those for *C. abyssii*.

1943: Original description as *Opuntia multigeniculata* Clokey.

1951: Treated as a species in the Flora of the Charleston Mountains (Clokey 1951).

1958: Treated as *Cylindropuntia multigeniculata* by Backeberg (1958).

1969: Benson places *Opuntia multigeniculata* as a variety under what is now *C. whipplei* (Engelm. & J. M. Bigelow) Knuth and includes *O. abyssii* Hester as a synonym.

1969: Reported from Zion National Park, Utah, by Trapp. Specimens were later described as *Opuntia echinocarpa* × *O. whipplei* by Trushell (1985).

1976: Individuals of intermediate morphology between *C. multigeniculata* and *C. whipplei* first collected in the Sheep Range by T. L. Ackerman, who identified them as *O. whipplei*.

1982: Benson maintains his 1969 taxonomic treatment.

1984: Welsh reports *Opuntia multigeniculata* as a species for which populations are restricted to Spring Mountains and vicinity in southern Nevada.

1985: Trushell excludes *Opuntia multigeniculata* from *O. whipplei*, even as a potential parent. She also excludes *O. abyssi* as a close relative of either *O. multigeniculata* or *O. whipplei*. Her findings were never formally published.

1987: Kartesz follows Benson's 1982 treatment for his list of Nevada plant taxa, which is based entirely on literature.

1988: *Opuntia whipplei* var. *multigeniculata* listed as "Candidate, Category 1 by USFWS, under 16 U. S. C. 1531 et seq., the Endangered Species Act as amended in 1988 (U. S. Fish and Wildlife Service 1990, p 6216).

1992: Status report for *Opuntia whipplei* var. *multigeniculata* prepared for USFWS (Great Basin Field Office) by James D. Morefield. Surveys indicate that the Blue Diamond Cholla was then thought to be restricted to the Blue Diamond Hill area. Surveys were negative for areas between the type locality and the southern Blue Diamond Hills, along Hwy. 160 between Blue Diamond Road and Cottonwood Pass Road, Cottonwood Pass Road for 1.5mi south from Hwy 160, and Cottonwood Pass Quadrangle, Bird Spring Range, eastward from Cottonwood Pass Road.

1997: Spiny-fruited form of *C. multigeniculata* collected on the north base of Bonelli Peak, Gold Butte area, by W. E. Niles, who identified it as *O. whipplei*.

1999: Pinkava (1999) recognizes *Cylindropuntia* as a genus separated from that of *Opuntia* [primarily based on new DNA evidence] and regards *C. multigeniculata* as a hybrid between *C. echinocarpa* (Engelm. & J. M. Bigelow) F. M. Knuth and *C. whipplei* (Engelm. & J. M. Bigelow) F. M. Knuth. Pinkava recognizes *O. abyssi* as a separate taxon from that of *C. multigeniculata*.

2002: Baker does phenetic study concluding that *O. multigeniculata* is a good taxon, closely related to *O. whipplei*, and that *O. whipplei* var. *multigeniculata* may be the best circumscription.

2003: John Anderson of the BLM, Phoenix discovers population of spiny-fruited *C. multigeniculata* NE of Kingman.

2003: Gina Glenne of the U.S. Fish & Wildlife Service, and Pat Putnam and Jed Botsford of the Bureau of Land Management discover new populations of *C.*

multigeniculata north of Las Vegas, near Gass Peak, in the Las Vegas Range; in the La Madre Mountain area, Spring Mountains; and in the McCullough Range.

2005: Baker (in press) reports that *C. multigeniculata* represents a good species and includes populations with spiny fruits that occur in Arizona and near Bonelli Peak, Nevada.

III. Present Legal or Other Formal Status

International:

CITES: Appendix II. Appendix II lists species that are not necessarily now threatened with extinction but that may become so unless trade is closely controlled. It also includes so-called "look-alike species", i.e. species of which the specimens in trade look like those of species listed for conservation reasons of the Convention). International trade in specimens of Appendix-II species may be authorized by the granting an export permit or re-export certificate; no import permit is necessary. Permits or certificates should only be granted if the relevant authorities are satisfied that certain conditions are met, above all that trade will not be detrimental to the survival of the species in the wild.

Federal:

USFWS/ESA: CANDIDATE for listing; which means that the species has been sufficiently studied and that the USFWS has decided that it should be proposed for threatened or endangered status. Within each Region, the pace at which new listing proposals are completed depends upon the funding appropriated by Congress to the listing and classification portions of the FWS budget.

BLM: Special Status Species. Bureau of Land Management (BLM) Manual 6840 establishes the Special Status Species (SSS) policy for plant and animal species and the habitat on which they depend. This SSS policy refers not only to species protected under the Endangered Species Act (ESA) but also to those designated by the State Director as Sensitive. Sensitive species include those that could easily become endangered or extinct in the state. Criteria set forth in the Glossary of Terms section of the 6840 Manual for designating sensitive species are:

1. Under status review by the FWS/National Marine and Fisheries Service(NMFS).
2. Those whose numbers are declining so rapidly that Federal listing may become necessary.
3. Those with typically small or widely dispersed populations.
4. Those inhabiting ecological refugia or other specialized or unique habitats.

USFS: none. No individuals of *C. multigeniculata* have been found on Forest Service lands.

State:

STATE OF NEVADA: FULLY PROTECTED. Nevada state law provides that a species or subspecies of the native flora shall be regarded as threatened with extinction when the state forester firewarden, after consultation with competent authorities, determines that its existence is endangered and its survival requires assistance because of overexploitation, disease or other factors or because its habitat is threatened with destruction, drastic modification or severe curtailment (N.R.S. 527.270). The law also authorizes a program for the conservation, protection, restoration, and propagation of selected species of flora and for the perpetuation of the habitats of such species (N.R.S. 527.260, .300).

Nevada Native Plant Society (NNNPS): THREATENED.

IV. Description

Non-technical: Low shrub, generally 0.5 meters tall at maturity and up to 1.5 meters broad, often with multiple trunks arising separately from the soil surface. The trunks leaning to erect, bearing numerous and dense, compact branches. These lateral branches, 1.5-2 cm thick and crowded with tubercles (raised areas). Each tubercle is 4-6 mm. long, 2-3 mm. wide, 4-5 mm. high and bears an areole (very short branch) toward the upper end. Each areole is 4-5 mm. long, 2-2.5 mm. wide, is filled with light, tan-colored wool-like hair, and possesses approximately 14 barbed, white-sheathed, delicate spines. Collectively, the spines of all the areoles almost conceal the surface of the stems. The innermost spines of each areole or central spines average seven in number and 19 mm. in length, and the radial spines (those arising from toward the outside of the areole) average 7 in number and 8 mm long. Flowers, which open in May, form from areoles toward the tip of mostly last-year's stems. The flowers are approximately 2.5 cm. long and broad. The pericarp (stem material that surrounds the ovary) is shallowly tuberculate with prominent areoles. The areoles toward the apex of the pericarp often possess very delicate, deciduous spines. The Inner tepals (petal-like appendages) are almost 2 cm long; are broadly spoon-shaped with blunt tips; and are pale green-yellow. The style (stalk bearing the stigmas) and stigmas (pollen-receptive areas) are cream-colored to pale yellow. Stamen filaments (stalks) cream-white, anthers yellow. Fruits, which mature in June, are sub-spherical to obconical (up-side-down top-shaped), leathery, yellow, approximately 2 cm. long, tuberculate, with few or no spines. The seed cavity is filled with a colorless jelly-like substance. The seeds are shaped like small disks approximately 1 mm thick and to 3mm in diameter. They are pale tan with a dull, smooth surface.

Technical: Annotated original Description from Clokey (1943). A low, semi-ascending [stems decumbent to erect], compact *Cylindropuntia* [shrub], 0.5 m or less high [tall], up to 1.5 m. wide, with stems having a weak, reticulated, woody framework; main stems [trunks] low tuberculate, about 1.5-2 cm. thick, with crowded lateral joints 3-5 [2-7] cm. long, about 2 [mean = 1.8] cm. thick; lateral joints [stems] with closely packed tubercles, 4-6 [4-12] mm. long, 2-3 [2.3 – 5.7] mm. wide, 4-5 [2-7] mm. high, with entire upper end of the tubercle occupied by an areole 4-5 mm. long, 2-2.5 mm. wide, filled with light,

tan-colored wool; spines about 12 [14], almost concealing the surface of the joints, delicate, white-sheathed, barbed; 2 to 4 [mean = 6.9] central spines 15-18 [mean = 18.6] mm. long; lateral spines very slender [mean = 0.3 mm]; leaves terete, apiculate, about 2 mm. long; glochids white, 1.5 mm. long, from the upper end of the areoles; flowers clustered at the tip of the joints [stems], about 2.5 cm. long and broad; ovary [pericarp] closely tuberculate; areoles prominent, oval, filled with light, tan-colored wool; spines few, very delicate, deciduous; perianth segments [inner tepals] light greenish-yellow, spatulate, obtuse or apiculate, 15-18 mm. long; style and stigmas yellow [more often cream-white, or tinged green]; stigma lobes 6-8; stamens yellow [filaments pale cream-white to pale yellow, anthers yellow]; fruit[s] globose, yellow with somewhat fleshy [coriaceous] walls, about 2 cm. high [long], tuberculate, spineless [or with a few (mean 1.2 per areole) weak spines], deeply umbilicate; seed cavity filled with colorless jelly [probably mucopolysachharrides]; seeds circular [orbicular or disk-shaped], light yellow [tan], dull, smooth, 2.5-3 mm. in diameter; commissure short, broad, distinct. Flowering in May; fruits developing July to September [most mature by end of June].

Field Characters: Mature individuals of *Cylindropuntia multigeniculata* generally possess several main stems or trunks that are crowded from the base with short, densely spiny branches. Trunks vary from erect to decumbent. The spines and spine sheaths are generally translucent white. Some individuals (ca. 1-2 %) have a yellow tint to the spines and spine sheaths. Individuals of its relative, *C. whipplei* var. *whipplei* have fewer, thicker spines. Individuals with morphology intermediate between *C. multigeniculata* and *C. whipplei* var. *whipplei* occur in the Sheep Mountains, north of Las Vegas. Individuals of *C. whipplei* var. *enodis* that occur near those of *C. multigeniculata* are diminutive plants with few spines and look very different than those of *C. multigeniculata*. Individuals of *C. multigeniculata* can be distinguished from those of *C. echinocarpa* because the lower portion of the trunk of the latter does not possess the persistent short branches. The habit of *C. echinocarpa* tends to be more openly branched, with long primary and secondary branches. The spines of *C. echinocarpa* are stout, and almost always pink-tan to dark brown; and the spine sheaths generally have a bronze cast, especially toward the apex. The fruit of *C. echinocarpa* are much spiner than those of typical *C. multigeniculata* and even a little spiner than those of the spiny-fruited forms of *C. multigeniculata*. Relative to individuals of *C. echinocarpa*, individuals of *C. multigeniculata* tend to occur in dense colonies. For example, within the geographic range occupied by *C. multigeniculata* [sensu lato], individuals of *C. echinocarpa* generally occur in densities of fewer than one or two per hectare, whereas those of *C. multigeniculata* commonly occur in densities of ten or more per hectare. Although individuals of *C. echinocarpa* occur fairly regularly, populations of *C. multigeniculata* are rare to infrequent.

Key to related species within the range of *C. multigeniculata*:

- A. Ultimate stem segments very easily detached, thick, averaging 28mm in diameter, stem tubercles about as long as wide..... *C. bigelovii* var. *bigelovii*

AA. Ultimate stem segments firmly attached, thinner, averaging 15-22mm in diameter, tubercles at least half again long as wide..... B

B. Trunks with few or no old persistent stem segments, ultimate stem segments averaging 22mm in diameter, with tubercle height averaging over 0.5mm and central spines averaging 5mm thick; most areoles of fruit with numerous (mean of ten or more) permanent spines ...*C. echinocarpa*

BB. Trunks generally bearing several to numerous persistent stem segments, ultimate stem segments averaging less than 17mm in diameter, with tubercle height averaging less than about 4mm; fruit areoles without spines, occasionally with a few deciduous spines, or, if fruits spiny, then central spines of stems thin, averaging 0.3mm...**C**

C. Central spines few in number, generally 2-4, averaging 0.4mm in thickness, radial spines 5 or 6 in number...**D.**

D. Fruits definitely tuberculate, generally bright yellow, wall of the pericarp much thinner than the width of the seed cavity; mean values include: stems 67 mm long and 18.2 mm wide, tubercles 9.3mm long and 4.7mm high, central spines 4.2 in number, radial spine length 6mm.... *C. whipplei* var. *whipplei*

DD. Fruit smooth to rather obscurely tuberculate; green to dull yellow, often tinged purple-brown; wall of the pericarp approximately equal to the width of the seed cavity; mean values include: stems 57 mm long and 13.4 mm wide, tubercles 7.0 mm long and 3.1mm high, central spines 2.5 in number, radial spine length 3.4mm.... *C. whipplei* var. *enodis*

CC. Central spines generally 6 or 7 in number, and 0.3mm in thickness; radial spines ca. 7 in number.....*C. multigeniculata*

Published Photographs and line drawings:

A photographs of *Cylindropuntia multigeniculata* occur in:

Clokey, Ira A. 1943. Notes on the Flora of the Charleston Mountains, Clark County, Nevada. V. Cactaceae. *Madroño: A West American Journal of Botany*. VII: 67-76.

Benson (1982), p. 309.

Morefield (1992)

A line drawing of *Cylindropuntia multigeniculata* occurs in:

Morefield (1992)

Baker, M. A. in press. Phenetic analyses in *Cylindropuntia* (Cactaceae): the circumscription of *C. multigeniculata*, *C. echinocarpa*, and *C. whipplei*; including the resurrection of *C. whipplei* var. *enodis* (see Appendix 2, figure 1).

V. Significance of Taxon

Natural: The apparent scenario within the taxonomic group that is beginning to be uncovered may prove to be of importance to the understanding of plant evolution and biogeography. Phenetic studies indicate a morphological cline from diploid *C. whipplei* var. *whipplei*, north of the Grand Canyon (Arizona Strip) to populations of *C. multigeniculata* var. *multigeniculata* in the Sheep Range, North of Las Vegas, and the Spring Mountains, NW of Las Vegas; then south to the McCullough Range, and finally back towards the east into Arizona (spiny fruited forms of *C. multigeniculata*). Further studies are needed in order to ascertain whether similar trends occur in other plant taxa and to correlate such trends with geography and climatic change.

Human: Individuals of *Cylindropuntia multigeniculata* occur occasionally in landscaping. The flower buds of *C. spinosior*, and possibly other species, are sometimes cooked and eaten. Those of *C. multigeniculata* are not as palatable (personal observation).

VI. Geographic Distribution

Geographic Range: The typical form of the species is endemic to Clark County, Nevada; from north of Las Vegas, near Gass Peak, in the Las Vegas Range; southwest into the La Madre Mountain area; south to Blue Diamond; and then southeast into the McCullough Range. Populations of the spiny-fruited form occur from Bonelli Peak, Gold Butte area of eastern Clark County, Nevada, south into the White Hills and Black Mountains of Mojave County, Arizona.

Historica sites (prior to 2002): Until recently, the only known population of

Cylindropuntia multigeniculata was the type locality, 2.8km north of the town of Blue Diamond, west of Las Vegas, Clark County, Nevada (Morefield 1992, Trushell 1985).

New sites discovered: New populations of *C. multigeniculata* (typical form with few spines on fruits) were recently discovered mainly through the efforts of Gina Glenne (USFWS), Pat Putnam (BLM) and Jed Botsford (BLM). Populations of the typical form are now known to occur in four general locations, all of which occur in Clark County, Nevada (Table 1). Topographic maps are presented in Appendix 3. The La Madre Mountain site is located NW of Las Vegas, 10 km WNW of the summit of Lone Mountain, East and NE of La Madre Mountain. The McCullough Site incorporates the McCullough Range, western bajada and valley, and smaller basalt mountains to the west; 20km SW of Henderson. Many individuals occurring in the McCullough Range possess spiny fruits and therein lies the primary reason for not taxonomically recognizing the two forms of *C. multigeniculata*. The Gass Peak site is in the southern end of the Las Vegas Range, just north of Las Vegas.

Populations of the spiny-fruited form of *C. multigeniculata* occur in Nevada in the eastern portion of Clark County, 75km east of Las Vegas; north and NE of Bonelli Peak. In Arizona, two generally locations were documented in Mojave County. The Hualapai Wash site is located north of Kingman in the areas of White Elephant and Hualapai Washes, 18km ENE of Senator Mountain, in the White Hills SE of Senator Mountain, and in the area 20km NNW of Red Lake. The Black Mountains site lies in the Black Mountains, 3.5km ESE of Burns Ranch, west of Kingman. Additional data, by population, is presented in Tables 1-3, Appendix 1; also see list of herbarium specimens, tables 8-9, Appendix 1.

A population comprised of at least some individuals morphologically intermediate between *C. multigeniculata* and *C. whipplei* var. *whipplei* occurs in the Sheep Range, near Joe May Canyon. Most individuals were observed in Black Gate Canyon, which is adjacent to Joe May Canyon. Populations of *C. whipplei* at higher elevations (Road to Saw Mill Canyon and Upper Peek-a-boo Canyon) in the Spring Mountains were visited by M. Baker in 2005 and all of the individuals observed appeared to be well within the morphological variability of *C. whipplei* var. *whipplei*.

VII. Habitat Characteristics

Environment and Habitat Summary: In Arizona and Nevada, *Cylindropuntia multigeniculata* were found growing in a variety of soils, including those derived from limestone, schist, granite and basalt. Soil types include sandy-loam, gravel, coarse-cobbled soils, silty alluvial fan terraces, decomposed granite and schist, and clays of volcanic origin. Plants generally prefer steep, dry, rocky slopes with minimal vegetative competition. Aspect varies depending on the area. In the Hualapai Wash site as well as in the area around Bonelli Peak, individuals grow in high densities in the washes and surrounding slopes of the bajadas. Associated plant species are listed in Table 2.

Physical Characteristics:

Physiography: The known range *Cylindropuntia multigeniculata* (including the spiny-fruited form) lies in the Mojave Desert portion of the southern Basin and Range Province in Nevada and Arizona. Broad, desert valleys of 2000-3000 feet elevation (610-915 m) are situated between isolated mountain ranges up to 9,000 feet elevation (2740 m). Many ranges are drained internally and accompanied by playas.

Climate: The climate of the Mojave Desert is characterized by wide temperature fluctuations and low annual precipitation. Tables 4-6 show average meteorological data for three locations; Red Rock Canyon National Conservation Area (NCA), which is near the La Madre Mountain population; Desert National Wildlife Range Headquarters, which is near the Gass Peak population; and Pierce Ferry, which is centrally located between the Bonelli Peak and Hualapai Wash populations (spiny-fruited form). Annual mean maximum temperatures vary between 72.3 (22.4) and 78.6° F (25.9° C). Annual mean minimum temperatures vary between 46.5 (8.1) and 47.8° F (8.7° C). Average annual rainfall varies between 4.3 (10.9) and 11.6 in (29.5 cm). The lower number was recorded at the Desert Game Range Headquarters, which is below the elevational range for *C. multigeniculata*. The average annual precipitation [10.6 in (26.9 cm)] for Pierce Ferry [3,860 ft (1177 m) elevation] was similar to that for Red Rock Canyon National Conservation Area [11.6 in (29.5 cm), 3,780 ft (1152 m) elevation], both of which are within the elevational range of *C. multigeniculata*.

Individuals of both forms of *C. multigeniculata* occur most abundantly where average precipitation is approximately 10 in (25.4 cm) and where annual average minimum temperatures do not fall below 46.5 ° F (8.1° C). Considering that similar average annual precipitation occurs throughout most of Nevada and into adjoining states (Desert Research Center, Western Regional Climate Center, <http://www.wrcc.dri.edu>), average annual precipitation does not appear to be a limiting factor in the overall distribution of *C. multigeniculata*. Average annual precipitation, however, probably does have an influence on the local distributions of individuals. Annual average minimum temperatures, on the other hand, probably do limit the northern distribution of *C. multigeniculata* and its relative *C. whipplei*. This is primarily evidenced by the distribution of *C. whipplei* as reported by Benson (1982), which continues only ca. 100 miles north of the southern Utah border. According to the 2003 US National Arboretum "Web Version" of the 1990 USDA Plant Hardiness Zone Map (<http://www.usna.usda.gov/Hardzone/hzm-sw1.html>), the distribution of *C. multigeniculata* falls within an isotherm where the average annual minimum temperature falls between 10 and 15 ° F (-12.2 and -09.4 ° C). **Average annual minimum temperatures** are based on the lowest temperatures recorded for each of the years 1974 to 1986 in the United States and Canada and 1971 to 1984 in Mexico. They should not be confused with the **annual average minimum temperatures**.

Soils: The typical form of *C. multigeniculata* occurs on both volcanic and

sedimentary soils. The vast majority of individuals recorded to date occur on limestone soils to the west and northwest of Las Vegas. Most, if not all of the individuals within the McCullough Range, however, occur on soils derived from basalt. Soils within the specific distribution of individual of the spiny-fruited form are primarily volcanic but vary between extrusive (basaltic and rhyolitic) to intrusive (granitic).

Hydrology:

Although most individuals of *C. multigeniculata* occur on rocky slopes, a number occur in flood plains and more often within dry, rocky washes. These latter individuals are generally protected by large rocks and/or boulders or are raised on small benches along the wash. Many of these individuals appear to have been established for several to many years.

Biological Characteristics:

Community physiognomy:

Populations of *C. multigeniculata* occur primarily on rocky slopes where the perennial shrub cover is low (ca. 5-15%). Although cover of annual plants is also generally low (<25%), values may vary dramatically depending upon amounts and timing of recent precipitation. The stature of most associated plants, like that of individuals of *C. multigeniculata* is short, with taller species occurring mainly along washes.

Vegetation type:

Populations of *C. multigeniculata* occur within what is often referred to as succulent scrub. Brown (1994) refers to this habitat type, at least within the range of *C. multigeniculata*, as Mohave desertscrub. Populations fall variously and often loosely within the following associations: *Larrea tridentata*-*Ambrosia dumosa*, *Larrea tridentata*-*Yucca*, *Coleogyne ramosissima*-*Yucca*, *Yucca brevifolia*-*Coleogyne ramosissima*, and *Yucca brevifolia*-*Larrea tridentata*.

Associated plant species:

Common associated plant species, along with their common names, for *C. multigeniculata* are provided in Table 2, Appendix 1. Associated species, by population are listed in Table 3.

Other endangered, threatened and sensitive species: Individuals of *Penstemon bicolor* are known to occur primarily along washes in the area of the La Madre Mountain, Blue Diamond, and Mc Cullough Range sites. Individuals of *Eriogonum heermanii* var. *clokeyi* occur on limestone outcroppings in the area of

La Madre Mountain and Blue Diamond sites.

Land Management: (Table 1, Appendix 1). Land Management was determined using GIS(Arcview® shapefile) of BLM 1:100:000-scale Surface Management Status maps.

Bureau of land Management (BLM) Las Vegas, NV, U.S Dept, of Interior:

The La Madre Mountain, McCullough Range, Bonelli Peak (spiny-fruited form), and a portion of the Blue Diamond sites.

Bureau of land Management (BLM) Kingman, AZ, U.S Dept, of Interior: Large portions of the Black Mountains and Hualapai Wash sites. Spiny-fruited form only.

Private Lands: Portions of the Blue Diamond Hill and Hualapai Wash populations.

Desert National Wildlife Range, NV: The Gass Peak population occur here, as well as some populations of *C. whipplei* that possess individuals (Joe May Canyon area) with morphology intermediate to those of *C. multigeniculata*.

State of Arizona: A portion of the Black Mountains site occurs on state land.

Lake Mead National Recreation Area: The extreme northern portion of the Hualapai Wash site.

VIII. Biology and Ecology

Population Summary: Populations of both forms of *C. multigeniculata* are somewhat geographically isolated from one another in that they occur within small areas compared to the size of the overall range (Figure 1). The occurrence of populations does not appear to be restricted by geological substrate, since individuals occur on several parent materials, topography, and soils of varying texture. The total number of individuals of the typical form of *C. multigeniculata* is ca. 100,000, most of which occur in the La Madre Mountain area. Although most areas within the range of *C. multigeniculata* have been visited, comprehensive surveys throughout the region have not been made. Areas to the south and southwest of the McCullough site are probably the least known. Individuals of the spiny form of *C. multigeniculata* number ca. 150,000. As with the typical form, general surveys have not revealed additional individuals beyond the populations reported here. Areas south of the Black Mountains site are the least known.

Demography: Populations appear stable at this time with both young and old individuals and there is no indication that populations are declining or increasing in size. No formal studies have been done on changes in demography through time.

Individuals of *C. multigeniculata* (both forms) tend to occur in relative high densities in

comparison to its closest relatives. For example, within the geographic range occupied by *C. multigeniculata*, individuals of *C. echinocarpa* generally occur in densities of fewer than one or two per hectare, whereas those of *C. multigeniculata* commonly occur in densities of ten or more per hectare. Although individuals of *C. echinocarpa* occur fairly regularly, populations of *C. multigeniculata* are rare to infrequent. Relative densities for each known population is presented in Table 1. These densities were from a series of 30m wide transects performed by Rafael Routson, July 2004. Locations of transects were chosen to maximize the likelihood that individuals would occur. Parameters used to assess potential habitat were, proximity to known individuals, substrate type, elevation, and slope inclination and exposure.

Phenology: New growth of stems and small leaves occurs between late spring and fall. The leaves fall soon after the new stem ceases to grow. Flowers appear from April to May, depending upon the amount of precipitation and spring warming. Fruits generally follow the maturation of flowers by several weeks. The bony seed may persist for several years before germinating and some degree of mechanical sclerification is necessary. Although seedlings have not been observed in the field, most *Cylindropuntia* seeds require summer temperatures for germination, thus germination probably occurs after the onset of summer rains.

Genetics: Andrew Salywon looked at ribosomal DNA but found little differences among *C. multigeniculata* and related taxa. New techniques, such as microsatellite analysis should be attempted, such as those now being done on other Cactaceae by Charlie Butterworth of the Desert Botanical Garden. *Chromosome numbers (Baker, in preparation)* are $n = 11$ for all individuals counted, both typical and spiny forms.

Reproduction and Dispersal:

Pollen-ovule ratio: Unknown but at least many-fold.

Seed set: Unknown.

Pollen stainability: 89.0% (Baker, in prep.), which is typical for sexually active, non-clonal species.

Seedling presence: During studies at Blue Diamond Hill in 1991 and 1992, Teri Knight and Glenn Clemmer reported between 0 and 20% of all individuals as seedlings (Morefield 1992).

Hybridization: Intergrades with *C. whipplei* var. *whipplei* in the Spring Mountains, Clark County, at least in the vicinity of lower Joe May and Black Gate Canyons. Populations of *C. whipplei* at higher elevations (Road to Saw Mill Canyon and Upper Peek-a-boo Canyon) in the Spring Mountains were visited by M. Baker in 2005. All individuals observed appeared to be well-within the morphological variability for the species. Putative hybrids have also been reported between *C.*

multigeniculata (both forms) and *C. acanthocarpa*. Hybrids are commonplace in the genus and the degree of hybridization recorded thus far bears little significance on the taxonomic recognition of *C. multigeniculata*.

Pathology: Unknown but dark, rotting spots are common on stems, which is common for the Cactaceae in general. No large outbreaks or cases of mortality have been reported.

Predation: Unknown but common insect herbivores include the cactus weevil (*Gerstaeckeria*) and the cactus moth (*Cactoblastis cactorum*). Although several mammals are known to eat *Cylindropuntia*, including rodents, deer, and cattle, no severe herbivory has been documented.

Competition: Although little is known, there appears to be very little competition from other plant species. This observation is based on the low densities of associated vegetation for all populations and on the relative high densities of individuals of *C. multigeniculata*.

Response to Disturbance: Unknown. Although many *Cylindropuntia* species appear to respond positively to mild levels of disturbance such as grazing and minor soil disruption, no studies specific observations have been recorded for *C. multigeniculata*.

Other Interactions: Unknown

IX. Evidence of Threats to Survival

Causes of impacts and threats observed or reported for the known sites are summarized in Appendix 1, Table 1.

Present or Threatened Destruction, Modification, or Curtailment of Habitat or

Range: Overall, very little disturbance as occurred within populations of either form of *C. multigeniculata*, and, to date, disturbances have not led to a high degree of mortality of individuals. In general, road construction and mining have been the prominent historical impacts. These impacts, along with potential commercial development, may increase in the near future, especially at the type locality on Blue Diamond Hill.

Road development and maintenance and off-road vehicle use: Because of the remote, very rocky, and often steep locations, there is very little, if any, threat from off-road vehicles. At the type locality at Blue Diamond Hill, there is at least one road that occur in the midst of *C. multigeniculata* individuals and may have been responsible for some mortality. Above elephant wash, Hualapai Wash area, AZ, the individuals of the spiny form may have been affected by mining. Several roads in the Hualapai Wash area have undoubtedly taken individuals.

Animal grazing or trampling: There have been no visible effects from animal

grazing or trampling. Historically, overgrazing is known to increase densities of individuals in at least some *Cylindropuntia*.

Mineral or leaseable materials exploration and development: A portion of the Blue Diamond population has been affected by mining and further threatened. The upper (east) margin of the population was being actively buried by mine tailings in 1990 and, according to Morefield (1992): "Most of the top of Blue Diamond Hill has now been scraped, cleared, mined, or otherwise disturbed". Mining activity is also evident in the McCullough Range, La Madre Mountain, and Hualapai Wash areas.

Urban and residential development: A portion of the Blue Diamond population is threatened by residential development. There has been at least one proposal for a large housing development on the top of Blue Diamond Hill. Private land also occurs in the Black Mountains and Hualapai Wash areas, AZ.

Utility corridor development and maintenance: Although there have been no impacts recorded from utility corridor development and/or maintenance, a proposal for the construction of an electric power plant (Blue Diamond Power Partners Inc., a partnership headed by Mitsubishi Corp.) on Blue Diamond Hill threatens the type locality (Las Vegas Mercury, Thursday, January 08, 2004)

Invasion of exotic plant species: Although some exotic weed species, such as *Bromus rubens* (red brome), have been recorded for areas within populations, there have been no direct impacts recorded. See also under "Competition".

Over Utilization for Commercial, Recreational, Scientific, or Education

Purposes: The greatest impact recorded from commercial, scientific, or educational purposes has been from research conducted by M. Baker, which included the removal of stems, flower buds, flowers, and fruits. In general, entire individuals of *Cylindropuntia* are rarely collected by enthusiasts, and few such incidences have been recorded. Nearly all cactus collectors would sample a few stems, which are easily rooted. It is doubtful that the removal of a few stems from a population would have a noticeable impact.

Inadequacy of Existing Regulatory Mechanisms: Potentially, the lack of a land swap that would potentially protect currently private lands on Blue Diamond Hill and, inversely, potential land swaps of BLM land within known populations of *C. multigeniculata* to commercial developers. Some commercial cactus dealers suggest that over-regulation leads to a lack of commercial availability and thus to a higher degree of poaching from the wild.

Other Natural or Man-Made Factors: None known, although some ranchers purposely remove individuals of *Cylindropuntia* and other cacti from grazing land. Air pollution, toxic run-off from mine tailings, and dust from mine access roads may be of concern (Morefield 1992; Nevada Natural Heritage Program 2001) .

X. General Assessment and Recommendations

General Assessment: Both form of *C. multigeniculata* and *C. multigeniculata* are narrow endemics with apparently healthy stable populations. Most of the populations occur in protected areas or within areas with no immediate threats. The most critical potential threats include commercial development and mining. At present, most individuals of the typical form of *C. multigeniculata* occur within the boundaries of Nevada National Conservation areas and mining is prohibited. Mining for gypsum or other products associated with calcareous substrates could potentially devastate populations of the typical form of *C. multigeniculata*. The Hualapai Wash area population of the spiny form of *C. multigeniculata* is also particularly susceptible to future mining operations. As presently recorded, these two populations represent the vast majority of individuals known for the species as a whole. The other major threat, commercial development, would only have a devastating effect only if the BLM swaps out BLM lands that currently support populations of *C. multigeniculata*.

Status Recommendations: STATE OF NEVADA: FULLY PROTECTED. The retention of the state status of this species is necessary to insure continued scrutiny, especially in the advent of any potential dangers to populations of *C. multigeniculata*. **BLM:** Special Status Species. As with the state status, the retention of the state status of this species as a federal concern is necessary to insure continued scrutiny of populations of *C. multigeniculata*. Additionally, it would provide incentive for continued monitoring of populations. After the formal publication, the BLM should also list populations of the spiny-fruited form as special status. **USFWS:** Listing is not recommended. Because of the apparent health of populations, densities of individuals, inaccessibility of habitat to ORV's, protection from mining and commercial development provided by the Red Rock Canyon and Sloan Canyon NCA's, and the Desert National Wildlife Range, the listing of *C. multigeniculata* is not recommended. Because Arizona populations of *C. multigeniculata* are presently not given any special protection, population monitoring is recommended.

Critical Habitat Recommendations: Critical habitat locations are recommend for areas of highest density in the La Madre Mountain, the McCullough Range, and the Hualapai Wash populations. With respect to the La Madre Mountain and McCullough Range populations, the fact that they are already within NCA's may obviate the necessity of critical habitat designation.

Conservation and Recovery Recommendations: No further survey work is recommended with regard to conservation considerations except when impending threats, such as mining, utility construction, and commercial developments, are proposed for areas within or near presently known populations. Occasional monitoring is suggested for the assessment of health and to determine population demography through time. For example, a cycle of every five to ten years would allow for climatic

perturbations, such as "El Niño" events or droughts, to occur between samplings. Although annual sampling is ideal for monitoring populations, moneys for such intense monitoring would probably be better spent on other rarer and more immediately threatened species. It is suggested that permits be given to qualified individuals to obtain material (stem segments or seeds) from wild populations in order to encourage the horticultural exploitation of the species. The occasional taking of a few stems or seeds from a population would have little impact on overall population survival and the availability of the species in horticulture may reduce poaching pressure. Conservation of the species should focus on preservation of habitat.

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Map Sources:

USGS 1:24,000 scale Topographic Series
Blue Diamond, Nevada
Sloan NE, Nevada
Grapevine Spring, Nevada
Jumbo Peak, Nevada
Gas Peak, Nevada
Burnt Mill Ranch (Gold Basin), Arizona
Burns Spring, Arizona
Garnet Mountain, Arizona

USGS 1:100,000 scale Topographic Series
Boulder City, Arizona-Nevada
Davis Dam, Arizona-Nevada-California
Lake Mead, Arizona-Nevada
Las Vegas, Nevada-California
Mesquite Lake, Nevada-California

Field Research: Field surveys for this report were conducted from 19-20 June 2003 and 16-21 July 2003 by Marc Baker and Rafael Routson.

Specimens: A list of herbarium specimens for *Cylindropuntia multigeniculata* is presented in Tables 7-9, Appendix 1. Type specimens are listed in the discussion of taxonomy.

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