At the Edge of Extinction: Useful Plants of the Border States of the United States and Mexico

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One in ten of five hundred wild relatives of New World crop plants are threatened or endangered in the border region of the United States and Mexico, yet little is being done to protect them

Most people who care about and study plants could easily cite reasons why endangered plants should be protected, reasons having little or nothing to do with potential gains from the plants's products (ornamental flowers, gums, resins, and so on) or from their ecological functions (the prevention of soil erosion, fixation of atmospheric nitrogen, and provision of habitat for wildlife, for example.) Such considerations are far less important than the intrinsic right of a species to exist (Callicott, 1986); in fact, laws dealing with endangered species usually exclude the use of economic or aesthetic criteria for determining whether a rare or threatened plant deserves legal protection.

Nevertheless, many lay people would like to know how currently endangered plants were used in the past and how they might be used in the future. Conservationists often hint at such uses when they argue that taxpayers ought to subsidize the protection of endangered species (Myers, 1983; Farnsworth and Soejarto, 1985). Unfortunately, their arguments have very often been far-fetched appeals that do not match the actual economic potential of endangered species.

One platitude offered by the mass media holds that a given endangered species may yield the hidden cure for cancer or other dread diseases. If we should lose that species, they argue, we may unwittingly lose a miracle drug it is "programmed" to produce. This argument assumes that (1) medical researchers seek a single panacea that could cure all kinds of cancer and (2), of the thousands of species already screened by pharmacologists and the hundreds of thousands of common species that remain, none are more likely than a species bordering on extinction is to yield the miracle drug. In short, the proponents of plant conservation have been vague and at times misleading in their responses to questions about the impor-

Opposite: *Four agaves native to the Borderlands region of the United States and Mexico. They are among the eighty or more wild relatives of crop plants from the Borderlands region that already have been or may yet be officially listed for protection under the Endangered Species Act because they are considered to be rare, vulnerable, or actually threatened*

Agave parviflora *Torr (top left) is in Category 2 (i.e., is under study for possible listing), while both* Agave mckelveyana *Gentry (top right) and* Agave utahensis *var* kaibabensis *(McKelv.) Breit (bottom left) are in Category 3C (i.e., are currently not subject to threat)* Agave cf. havardiana *Trel (bottom right) has not been listed by the Fish and Wildlife Service*

The photographs were taken in Arizona and Texas by Susan Delano McKelvey of the Arnold Arboretum during the 1920s and 1930s as follows —Agave parviflora *Sierra Parajito, Arizona, 1930,* Agave mckelveyana *Sierra Ancha, Arizona, 1929 (the type locality of the species),* Agave utahensis *var.* kaibabensis *Kaibab National Forest, Arizona, 1934 (the type locality of the species), and* Agave cf. havardiana *Miller's Ranch, near Limpia Creek, Jeff Davis County, Texas, 1931 Photographs from the Archives of the Arnold Arboretum*

tance of endangered plants to human beings.

Fortunately, there are meaningful responses to such questions. Before their habitats came under attack, a number of endangered species provided American Indian peoples with food, fiber, medicine, or ceremonial materials; some still are important in Indian (or "Native American") cultures. Species (or other taxa) needed for healing and ceremony may continue to be available under the legal sanction of the Indian Freedom of Religion Act. Plant breeders are now using an additional set of wild species, some endangered, others closely related but more abundant, as donors of genes to species of crop plants in the same respective genera. While the improvement of crop plants through the use of "wild" genes usually proceeds slowly, by a series of small increments rather than in large steps, the improvements gained do increase the resistance of modern crops to pests, diseases, and stress and also enhance the nutritive value of the crops (Prescott–Allen and Prescott–Allen, 1983). The following discussion therefore offers examples of rare or threatened plants that (1) have a long history of use by people and/or (2) are being considered by plant breeders as potential sources of genes for crop improvement. The discussion focusses on species that are native to the "Borderlands"—the border states of California, Arizona, New Mexico, and Texas in the United States and Baja California Norte, Sonora, Chihuahua, Nuevo León, Coahuila, and Tamaulipas in Mexico, which have a common history of land and plant use.

Ethnobotanical Uses

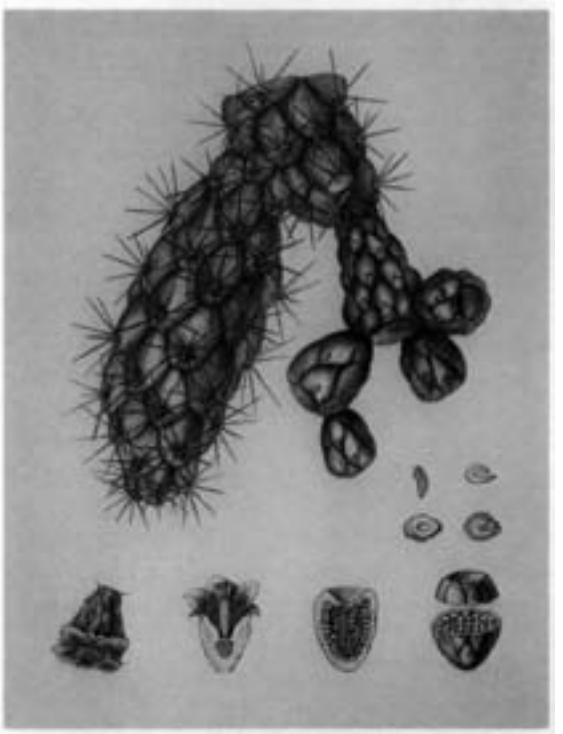
To determine whether any of the rare or endangered plants in the border states ever contributed to the well-being of the human inhabitants of those states, we consulted several compendia of ethnobotanical data, including Altschul (1973), Burlage (1968), Clarke (1977), Hodgson (1982), and Yankovsky (1936). We also drew upon detailed botanical ethnographies of Native cultures of this desertic and mountainous region. Among the cultures described were those of the Apache (Gallagher, 1977), Cahuilla (Bean and Saubel, 1972), and Seri (Felger and Moser, 1985). The results, summarized in Table 1, indicate that over forty rare, threatened, or endangered species were historically used directly for food, clothing, medicine, or other purposes. These forty-odd species belong to twenty-seven genera, which are indicated by os in Table 1. A further one hundred twenty-seven genera that contain species at risk (indicated by +s) were also used. Thus, one hundred fifty-four genera of plants used by Native Americans in either prehistoric or historic times contain species that now are at risk in the ten border states of the United States and Mexico. No fewer than one hundred fifteen genera were used directly as medicines or indirectly in ceremonies for healing, fertility, or protection.

What is the significance of such numbers? They suggest that a staggering diversity of plants now facing extinction belong to genera that played major roles in feeding and healing early Americans. Because few early ethnographic sources reliably identified plants to the level of species, it is difficult to be sure that particular species now threatened or endangered were routinely used in historic times. Because of this uncertainty, we have had to present and analyze data at the level of genus. Nonetheless, when we find that most species in a genus such as *Arctostaphylos*, *Opuntia*, or *Rubus* were used for food, we can confidently assume that the rare species in those genera were also comestible and probably were eaten whenever they were encountered.

Did such use endanger these plants? Of the twenty-eight genera for which we know that particular species now at risk definitely were utilized, a few such as *Agave*, *Echinocactus*, *Calochortus*, *Dudleya*, and *Triteleiopsis*, could

have suffered if they had been used intensively. Others, such as plants that bear berries, grains, or achenes, probably were not dramatically affected by harvesting itself. On the contrary, in the overwhelming majority of cases, recent destruction or degradation of habitat has more severely threatened these plants than did localized overharvesting in historic times.

In several instances Native Americans have protected or favored rare species in habitats that were modified by man. For example, *Helianthus anomalus*, a wild sunflower, is protected in Hopi Indian sand-dune fields, where its flowers are harvested for ceremonial purposes (Nabhan and Reichhardt,



Opuntia fulgida *Engelm., the jumping cholla, a cactus common in the Sonoran Desert and a potential crop plant for arid lands. In coastal Sonora, Mexico, the Seri Indians harvest fruit from specific stands and individual plants of* Opuntia fulgida *that consistently bear fruit several times larger than usual. Fruit size appears to be genetically controlled. Drawing by C. E. Faxon.*

C. E. Faxon's drawing of Triteleiopsis palmeri *(S. Wats.) Hoover, the blue sand lily of Mexico and extreme southwestern Arizona. At one time this species was in Category 1 but later was placed in Category 3C as more information became available. Though common in Baja California, it is not common in Arizona, where it receives protection under the terms of the Arizona Native Plant Law (because it is a member of the Liliaceae). Native peoples of the Borderlands area use it for food. First published, in* Garden and Forest *magazine, in 1889 (the year the species was described), this drawing is from the Archives of the Arnold Arboretum.*

Table 1 Native American Uses of Genera Containing Plant Species At Risk in the U.S./Mexico Borderlands

○: Evidence exists that Native Americans of the Borderlands have used one or more threatened or endangered species in the genus for the indicated purpose.

+: Evidence exists that Native Americans of the Borderlands have used one or more species in the genus for the indicated purpose, but none that they used any of the threatened or endangered species belonging to the genus that occur there.

Genus	Common Name of Genus	Tannin, Glues, Dyes, Paints	Wood, Construction, or Tools	Cosmetic or Soap	Medicine or Ceremonial Healing	Clothing or Adornment	Food or Beverage
Abronia Juss.	Sand verbena			+			
Acacia Mill.	Acacia	+		+		+	+
Acer L.	Maple, ash	+		+	+	+	+
Agave L.	Century plant	○	○	+	○	+	
Allium L.	Onion	+		+			
Ambrosia L.	Bursage			+			
Amoreuxia Moç. & Sessé	Yellowshow	+	+				
Amorpha L.	False indigo			+			+
Andrachne L.	Maidenbush			+			
Anemone L	Anemone			+			
Aquilegia L.	Columbine	○		+			
Arctostaphylos Adans.	Manzanita	○		○		+	
Arenaria L.	Sandwort			+			
Argemone L	Prickle poppy			+			
Asclepias L.	Milkweed	+	+	+	+		
Aster L	Aster	+		+	+		
Astragalus L.	Milkvetch	+					
Atriplex L.	Saltbush	+		+	+	+	
Baccharis L.	Desert broom			+	+	+	
Boerhavia L.	Spiderling	+					
Bouteloua Lag.	Grama	+					
Brickellia Rafin.	Brickellbush			+	+		
Brodiaea Sm.	Blue dicks	+					
Caesalpinia L.	Bird of paradise	+		+			
Calliandra Benth	Fairyduster			+			
Calochortus Pursh	Mariposa lily	+					
Camissonia Link	Evening primrose	+			+		
Cardamine L.	Bittercress			+			
Cardiospermum L	Balloonvine		+				
Carex L.	Sedge			+			
Cassia L.	Senna	+		+			+
Castilleja Mutis	Paintbrush			+			+
Caulanthus S. Wats.	Squaw cabbage	+					
Ceanothus L.	Wild lilac			+			
Celtis L.	Hackberry	+				+	
Cereus Mill	Night-blooming cereus	○		○	○		
Chrysothamnus Nutt.	Rabbitbrush			+			
Cirsium Mill.	Thistle	+		+			
Citharexylum Mill.	Mission fiddleweed	○		+			
Colubrina L. Rich. ex Brongn.	Snakewood	+			+	+	+
Condalia Cav.	Graythorn	+		+	+		

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Conyza Less	Horseweed			+			
Cowania D. Don	Cliffrose					+	+
Crataegus L	Hawthorn	o				+	
Croton L	Croton			+		+	+
Cryptantha Lehm	Hidden flower			+			
Cucurbita L	Gourd	+		+	o	o	
Cymopterus Rafin.	Corkwing	+					
Cyperus L	Flatsedge	+					
Dalea L ex Juss	Prairie clover	+		+			
Desmodium Desv	Tick-trefoil			+			
Draba L	Draba			+			
Dudleya Britton & Rose	Live-forever	o		+			
Echinocactus Link & Otto	Barrel cactus	o		+			
Echinocereus Engelm.	Hedgehog	o		o			
Eleocharis R. Br	Water chestnut	+					
Epilobium L	Fireweed	+		+			
Erigeron L	Fleabane			+			
Eriogonum Michx	Buckwheat	+		+		+	
Errazurizia Phil	Errazurizia		+				
Eryngium L	Rattlesnake master			+			
Eysenhardtia Kunth	Kidneywood					o	
Ferocactus Britton & Rose	Barrel cactus	o		+			
Frankenia L	Frankenia			+			
Gaillardia Foug.	Blanket flower			+			
Galium L	Bedstraw	+					
Gaura L	Gaura			+			
Gilia Ruiz & Pavón	Gilia			+			
Gossypium L	Cotton	+	+	+			
Grindelia Willd	Gumweed			+			
Hedeoma Pers	Oregano	o		o			
Helianthus L.	Sunflower	+		+			+
Hibiscus L	Rose mallow	+		+			
Hoffmanseggia Cav	Hog potato	+					
Hymenoxys Cass	Bitterweed			+			+
Ipomoea L	Morning-glory	+		+			
Iresine P Br	Bloodleaf			+			
Juglans L	Walnut	o				o	o
Justicia L	Hummingbirdbush	+		+			
Kallstroemia Scop.	Caltrop			+			
Lechea Kalm ex L	Pinweed			+			
Lepidium L.	Peppergrass	+					

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Lesquerella S. Wats.	Bladderpod	+		+			
Lobelia L.	Lobelia			+			
Lomatium Rafin	Cow-parsnip	+		+			
Lonicera L	Honeysuckle	+		+			
Lycium L	Wolfberry	+	+				
Machaeranthera Nees	Spiny-aster			+			
Magnolia L	Magnolia			+			
Mahonia Nutt.	Mountain grape	o					o
Mammillaria Haw.	Fishhook cactus	o					
Manihot Mill	Cassava	+		+	+		
Matelea Aubl.	Matelea	+					
Mentzelia L	Stickleaf	+		+			
Mimosa L	Mimosa	+		+		+	+
Mimulus L.	Monkeyflower	+		+			
Monardella Benth	Monardella	o					
Muhlenbergia Schreb	Muhly	+					
Nolina Michx	Beargrass	+	+				
Notholaena R Br.	Cloakfern			+			
Oenothera L	Evening primrose			+	+		
Opuntia Mill	Prickly pear, cholla	o		+			
Osmorhiza Rafin	Sweetroot			+			
Ostrya Scop.	Hop hornbeam			+		+	
Panicum L	Panicgrass	o					
Pectis L	Chinchweed	+		+			
Penstemon Mitch	Beardtongue	+		+			
Peridendia Rchb.	Squaw root	o		o			
Phacelia Juss.	Phacelia			+			
Phaseolus L	Bean	+		+			+
Pholisma Nutt ex Hook	Sandfood	o					
Phyllanthus L	Leaf-flower			+			
Pinus L	Pine	+	+	+	+	+	+
Polygala L	Milkwort			+			
Polygonum L	Smartweed	+		+			
Porophyllum Guett.	Poreleaf	+		+		+	
Proboscidea Schmidel	Devil's claw	+	+	+	+	+	
Prunus L.	Plum, cherry	+		+			+
Psoralea L	Scurfpea	o		+			+
Quercus L.	Oak	+		+		+	+
Rhus L	Sumac	o		+		+	+
Ribes L.	Gooseberry	+		+			
Rorippa Scop.	Watercress	+					

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Rosa L.	Rose	o		+			
Rubus L.	Blackberry	+		+			
Rumex L.	Dock	+		+			
Sabal Adans.	Palmetto	+	+			+	
Salix L.	Willow			+	+	+	
Salvia L.	Sage, chia	+		+	+		
Scutellaria L.	Skullcap			+			
Sedum L.	Stonecrop			+			
Selaginella Beauv.	Resurrection plant	+		+			
Senecio L.	Groundsel			+			
Silene L.	Catchfly	+		+	+		
Solanum L.	Nightshade, potato	+		+			+
Sphaeralcea St.-Hil.	Globe mallow			+			
Spigelia L.	Pinkroot			+			
Stephanomeria Nutt.	Wire lettuce					+	
Styrax L.	Snowbell			+			
Symphoricarpos Duh.	Snowberry	+		+			
Talinum Adans.	Flameflower	+		+			
Taxodium L. Rich.	Bald cypress			o			
Thalictrum L.	Meadowrue	+		+			
Thelypodium Endl.	Thelypody			+			
Trifolium L.	Clover	+		+			
Triteleiopsis Hoover	Blue sand lily	o					
Vaccinium L.	Blueberry	o		+		+	
Valeriana L.	Valerian	+		+			
Valerianella Mill.	Little valerian	+					
Verbena L.	Verbena			+			
Viguiera HBK	Goldeneye			+			
Yucca L.	Yucca	+	+	+	+	+	
Zanthoxylum L.	Tickletongue			+			
Zizania Gron. ex L.	Wild rice	+					

1983). In a recent excellent study by Housley (1975, and *in press*), *Opuntia imbricata* and the rare *Opuntia whipplei* var. *viridiflora* were shown to be highly associated with Pueblo Indian habitation sites in northern New Mexico. Similarly, *Agave murpheyi* in Arizona and Sonora is found almost exclusively around prehistoric ruins or contemporary O'odham Indian villages. Either by tolerating or directly propagating these spe-

cies, Native Americans have conserved the plants's gene pools.

Potential Uses as Genetic Resources

In addition to their long history of direct use for food and other purposes, many plants of the Borderlands are now considered to be useful indirectly, as potential genetic resources. Some genera that contain crop-plant species also contain cross-compatible wild taxa that are capable of "donating" their genes through conventional breeding or new, biotechnological, methods. The wild taxa are said to be part of the same "gene pool" as the crop-plant species. Geneticists are now using the wild taxa on an unprecedented scale.

Roughly five hundred wild species of plants in twenty-eight genera native to the border states of the United States and Mexico are "crop relatives" (Nabhan, 1986). Not all of the five hundred will eventually be found able to exchange genes with crops by currently available techniques, but about 5 percent already have been artificially crossed with their closest domesticated kin. In some cases the results have already proven to have been worth the effort and cost. Sunflowers, strawberries, chile peppers, cotton, and cherries have already benefitted from controlled interbreeding with related species from the wilds of the Borderlands. Genes for disease

Richard Pentewa, a Hopi farmer, and Karen L. Reichhardt, a botanist with Native Seeds/SEARCH, pose in a field of Helianthus anomalus *Blake. This rare wild sunflower is protected in Hopi fields and is used ceremonially. Photograph by Gary Paul Nabhan*

Table 2 Wild Relatives of Crop Plants At Risk in the Borderlands of the United States and Mexico

Genus	Name(s) of Crop(s)	Number of Species		
		At Risk	Proposed or Listed as Threatened or Endangered	Already Used in Breeding?
Agave L.	Sisal, tequila, henequen, pulque	17	4	Yes
Crataegus L	Hawthorn	3	2	Not known
Gossypium L	Cotton	1	–	Not known
Helianthus L	Sunflower, sunchoke	11	4	Yes
Iva L	Sumpweed	1	–	No
Macroptilium (Benth.) Urb.	Siratro	1	–	No
Manihot Mill	Cassava	2	1	Not known
Opuntia Mill	Prickly pear	10	9	No
Panicum L.	Sonoran millet	1	–	No
Phaseolus L	Bean, lima, tepary	3	–	Yes
Proboscidea Schmidel	Devil's claw	2	–	No
Prunus L	Cherry, plum	2	–	Yes
Ribes L	Currant	7	1	Not known
Rubus L	Blackberry	4	1	Not known
Salvia L	Chia, sage	8	3	No
Solanum L	Potato	5	1	Yes
Vaccinium L.	Blueberry, cranberry	2	–	Yes
Zizania Gron ex L	Wild rice	1	1	No

resistance, pest deterrence, drought tolerance, salt exclusion, nutritive quality, and cold hardiness have been found in the relatives of other crops, among them beans, cassava, sisal, grains, potatoes, and blueberries. Though not obvious in grocery stores, wild genes nevertheless are there—within produce. More genes are sure to follow.

The Southwest is, perhaps, the richest source of crop relatives in the United States. Northern Mexico, because of its vegetational history, is even richer. Yet more than eighty taxa of crop relatives in this binational region are at risk (Table 2) because of both their natural rarity and direct threats from human beings and their livestock. By conservative estimate, 10 to 15 percent of the wild congeners of crops in the border states of the two countries should eventually be put on official lists of threatened and endangered species.

The habitats of these plants are being destroyed through conversion to agriculture and through the development of water resources by dams and the pumping of groundwater. Ironically, the agriculture being made possible through the destruction of habitat someday may need the traits for hardiness borne in genes of the wild plants it is displacing.

It is disconcerting to realize that the habitats of the few threatened crop relatives found in parks and nature sanctuaries of the United States are not necessarily being managed so as to favor the threatened species. Many of these species are "disturbance-adapted" and, therefore, components of pioneer ecosystems. The suppression of fire, prevention of floods, and abandonment of

small-scale Native agriculture actually cause populations of these plants to wane.

At present, few threatened crop relatives or ethnobotanical resource plants are cultivated by botanical gardens or seed banks. Fortunately, however, through the leadership shown by the Center for Plant Conservation, Native Seeds/SEARCH, North American Fruit Explorers, and individual botanical gardens, efforts to cultivate them are now on the upswing (Office of Technology Assessment, 1986). The historic neglect of the most valuable of our threatened and endangered plants is being corrected. We hope that these potentially useful organisms—whether they reach the kitchen table or not—will be growing many generations from now.

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