{2016_06_08_Desert is Food}

Richard Felger
University of Arizona Herbarium
Tucson, AZ 85721
rfelger at email.arizona.edu

Neil Logan
Forest **A**griculture **R**esearch **M**anagement Center
PO Box 551754
Kapa'au, HI 96755

The Desert is Food

Richard Felger and Neil Logan

Impoverished places with a scarcity of healthy foods are called food deserts. But Apache elders say, "The Desert is where the Food is."

The Sonoran Desert is a hundred thousand square miles surrounding the northern Gulf of California [include a map?] and supports two thousand five hundred species of seed plants. Native Americans used four hundred fifty for food—some as staples and others as snack foods. Our interest is drawn to the staples, diverse and intriguing: desert tree legumes, cactus fruits, seawater grain and other perennial grains, desert goji berry, and desert fan palm.

The Sonoran Desert is an ideal place for economically viable native food crops, especially long-lived perennials for no-till agriculture. Some water is needed, although minimal compared to non-desert crops, and poor quality water is okay. Organpipe fruit for beverages including superior wines, preserves, flavoring and more–one of the world's best fruits, almost as good as *pitaya agria* from Baja California, another cactus suitable for developing (hybridizing?). Native desert fan palm—large yields of small date-like fruits—a high-water user but only a small area needs irrigating and wastewater will do. Mesquites for farming the future. Foothill palo verde for high-protein seeds. Desert wolfberry, in the same genus as goji berry. And there are more. Hedge your bets; intercropping food plants for farms as well home gardens. High nutrition, taste, and local food resiliency—and markets exist for local foods. It's a drying world. Fit the crop to the land, not the land to the crop.

If you harvest wild plants, leave plenty for renewal and the animals.

PROSOPIS

Prosopis, in the Legume Family, includes about 45 species of trees and shrubs in arid and semiarid regions of the world.

Prosopis pubescens. Screwbean, *tornillo*. These small trees grew along desert rivers and waterholes from California to Texas and adjacent northern Mexico. The pods, harvested in early summer, were parched or buried in a pit to "ripen" or partially ferment, and ground into flour. The sugar-rich pods were sometimes fermented as a beverage. In 1699 people near present-day Yuma gave Manje "some bread" made from screwbean flour. Like mesquite pods, whole screwbean pods often were stored in rooftop granaries. Screwbean is gone from much of its former range due to loss of wetlands.

Section **Algarobia** of *Prosopis* includes hardwood, nitrogen-fixing trees—six species in North America known as *mesquite*, and two dozen in South America often called *algarrobo*. Some are naturalized and invasive in distant parts of the world. Mesquites and algarrobos were

part of everyday life of native peoples who were agriculturalists as well as hunter/gatherers. *Algarobia* offers the world's first major new food crop since soy.

The roots harbor nitrogen-fixing bacteria and fungal allies facilitating growth in harsh environments. The pods are large and indehiscent (not splitting on ripening; the contents do not fall away)—one of the major factors in domestication of crop plants. Pods are sun-dried or fire-parched to reduce moisture content, control insects, and make processing easier. The dry pods were crushed or ground into flour, often in a bedrock or wooden mortar. Modern methods include hammer mills and other mechanical means.

The bulk of the pod, the pulp (mesocarp) is rich in calories/carbohydrates with a balanced amino acid profile. The hard, protein-rich seeds are encased in a tough, leathery endocarp. The husk (exocarp) and endocarp are not digestible but can add dietary fiber to the flour. Mesquite foods can be prepared without cooking, e.g., pods steeped in water for *atole de mesquite* or made into tortillas or cakes, or fermented into alcoholic beverages. The flour is hygroscopic and should be stored in dry conditions. There is much variation in pod size and taste—some have an apple-like flavor and others contain phyto-nutrients like the anthocyanin pigments in blueberries. Mesquite honey has become economically important since introduction of honeybees from the Old World. White honey from *Prosopis limensis* in Hawaii is one of the finest gourmet honeys. Countries in the South American *Chaco* are developing *Prosopis* as a major food resource.

By-products of pod processing can be feedstock for mycoculture and aquaculture systems, increasing the protein output through biological conversion. Other products include ethyl alcohol from the pods and bio-energy from the wood.

Tropical species such as *P. limensis*, native in Peru and naturalized in Hawaii, can produce three or more crops of pods per year. Others, in deserts and arid lands at higher latitudes, such as *P. velutina* in Arizona, tend to produce one large crop in early summer and additional pods into the fall. People knew of trees or groves with sweeter pods and superior yields. The wood is a high-quality, clean-burning fuel, preferred for cooking and widely used for charcoal, construction, and numerous products. The gum and black sap have served as medicine and dye.

Studies indicate annual pod yields of 2–4 tons per hectare in the colder-tolerant species such as *P. velutina* from the northern hemisphere, or *P. alba* in the southern hemisphere, while the tropical species *P. limensis* may yield up to 10 tons per hectare. Mesocarp-flour yields are in the range of 1–5 tons per hectare per year depending on the species and environment. Centuries-old trees in South America, Hawaii, and southwestern U.S. are still yielding large quantities of pods. *P. limensis* established in Hawaii may sequester as much as 1.2–8.9 tons/hectare/year of carbon, the range based on soil type.

If total available food value of the *Prosopis* tree is used, depending on the species and environment, one hectare of land may provide food calories for 4–44 people annually. At these rates only 0.5% of the available terrestrial landmass of the planet could provide calories for 4.5 billion people.

THE FUTURE OF *PROSOPIS* IS NOW

The last time the planet had 400 ppm of atmospheric CO_2 coincided with *Prosopis* expansion of the late Miocene. About 15 million years ago atmospheric carbon levels ranged between 300 and 500 ppm, temperatures were 3–5 degrees Celsius hotter than the beginning of the industrial revolution and sea levels were 100–200 feet higher (Greenop et al. 2014). As the inland seas on the North and South American continents receded they left vast saline deserts. These became the domain of *Prosopis*, from which many of the present-day species evolved. These rapid-growing, nitrogen fixing, C3 organisms transpired endlessly, pumping fresh water into the atmosphere while breathing in the carbon floating in the air to create new soil.

Megafauna of that era helped spread trees with abundant, sweet, nutritious pods. In South America, the spectacled bear and camelids such as the guanaco are notable as later (Pleistocene) dispersal agents. This epoch molded and shaped the species that early people came to cherish as a

veritable "tree of life" while migrating through the Americas. As early as 10,000 years ago *Prosopis* pods formed the nutritional foundation of some of the first civilizations along the Pacific Coast of South America. In what is present day Peru, people whose staple was *Prosopis* built pyramids, smelted gold, and recorded their cultures on pottery thousands of years before the advent of corn (*Zea mays*).

The ancient cowboys of northern Africa, the Iberian Peninsula, and the Middle East mastered the craft of using horses for the domestication of cattle. Pods of the carob tree (*Ceratonia siliqua*) were the feedstock of choice for horses and cows, and provided food and firewood for people. This phreatophyte with nitrogen fixing bacteria dwelling on its roots became the mainstay of the early cowboy. The fruits of the carob tree are known as *karuba* in Arabic and *algarroba* in Spanish. They have a nutritional value similar to barley and were likewise fermented into beer.

The Spanish brought cattle to the New World in the early 16th century. The cow became a dominant dispersal agent, spawning a new mesquite proliferation. The Spanish recognized *Prosopis* fruits as being similar to carob pods. They saw a tree that fit their established system of colonization. Cattle could be transported to new lands and released into the ecosystem where they would consume foreign (to them) vegetal matter and transform it into something Spaniards knew they could eat: beef. However, as the Jesuit Martín Dobrizhoffer (1822:402) cautioned in his account of the *Abipones of Paraguay,* "*...neither did we ever think fit to plant the algarroba, which grows so quickly, lest the Abipones, like the other Indians, should turn it to a bad use, and that it should cause drinking-parties and intoxication. Moreover the seeds of the algarroba, if carelessly scattered in any soil, will certainly, and quickly grow up into trees."*

Ultimately, the west was "won" (i.e., domesticated) via cattle and fences. The Hawaiians received cattle as a gift from Captain George Vancouver in 1793. Spanish-American-Indian cowboys (*vaqueros*) were recruited to Hawaii, where they taught Hawaiians to become *paniolos* (Hawaiian cowboys). During the late 1800s and early 1900s, paniolos helped operations like the Parker Ranch grow into one of America's top ranching outfits. The process was incredibly successful. Paniolos and their cattle covered the deforested dry slopes of all five major islands with a continuous unbroken forest of *Prosopis limensis*. This new forest ranged from the coast of each island to more than 2,000 feet elevation in some places. In doing so, not only did the Hawaiian cattle ranchers reforest the arid parts of the islands, replacing the previous legacy of sandalwood deforestation, they also formed some of the most productive cattle operations in the United States.

Attempting such a massive reforestation effort in Hawaii using current conservation methods (i.e., by hand) would be prohibitive in cost. With current world population at nearly 7.5B and rapidly approaching 9B we need the power of *Prosopis* to help mitigate atmospheric carbon while feeding a hungry planet. Increased food production needs to go hand in hand with family planning.

Modern processing technology can help break apart *Prosopis* fruits into their primary components: exocarp, mesocarp, endocarp, and seed. We can replace the mortar and pestle of the past with Bauer Mills and Trilladores Cosiansis to produce an array of food products. Much like corn, *Prosopis* pods can be fractionated into many sub-fractions and used as an industrial feedstock. The key difference is that corn is entropic, requiring consistent, high water input and heavy fertilization and depletes the soil. *Prosopis* is biogenic, enriching the soil through nitrogen fixation and leaf litter, increasing humidity through the action of its canopy, and encouraging the creation of ecosystems: "99 years of mesquite for 1 year of corn."

We need to remove stumbling blocks to make *Prosopis*-based foods widely available. First, *Prosopis* has a reputation as a thorny invader. Second, not all *Prosopis* are created equal. Arturo Burkart (1976: 522) points out, in Argentina "trees with straight trunks 8 to 10 m tall occur, but these are becoming extremely rare, from being cut in preference to the other shorter

ones. Thus a negative, artificial selection is taking place, which should be counteracted by genetic up-building of the best lines in experimental plots."

We can overcome negative "artificial selection" by utilizing what we know of historical dispersions and creating small-scale, controlled naturalizations. These controlled naturalization events can spread one paddock at a time in a manner similar to traditional crop rotation, such as in the Andes. First, a crop of corn is grown inside a paddock surrounded with a fence or traditional animal control barrier (hedges of agaves and cactus, etc.). After the corn is harvested, cows are brought into the paddock to eat the corn stubble supplemented with rations of select *Prosopis* pods. The cows poop and stomp the *Prosopis* seeds into the mud, creating temporary feedlot conditions that serve to suppress competitor weeds and fertilize the plot. After the cows are removed the seeds germinate with the next rainfall and a *Prosopis* thicket arises.

The thicket creates competition for light among the young trees, forcing them to reach higher. Later, the thicket is pruned of thorny plants and horizontal stems, leaving tall trees with wide spacing. As the tree canopies fill, they begin to bear fruit. Further selection can be made for disease-resistant trees with abundant tasty pods and few or no thorns. What is left is a productive orchard of superior trees. The seeds can be used to start a new paddock and the process repeated.

This low-tech strategy has financial and functional advantages. Neil Logan's survey of *Prosopis* orchards in Latin America and Hawaii has turned up a crucial factor: development of the radicle (taproot) is one of the most important indicators of successfully established, highly productive orchards. Cattle planting *Prosopis* as described above gives rise to a phenotype best suited to the site. Perhaps most important, the taproot is not disturbed, as it would if transplanted. This enables the young tree roots to find deep underground water reserves vital to abundant pod production in the desert during drought.

Taco (The Tree), as it is known to the Quechuas of the southern Andes, is an unfailing crop providing abundance when and where it is too hot and dry for other crops. It's not that *Prosopis* grow without water; rather it is their ability to tap water that few other trees can reach. *Algarobia* species have a dimorphic root system consisting of a deep taproot essential for reproduction and shallow lateral roots largely supporting vegetative growth. The foliage can help precipitate ambient moisture, misty rains, fog, or high humidity, which falls to the ground and becomes available to shallow roots. However, summer heat may evaporate moisture droplets before they reach the ground. The deep taproots are anchored in cool subterranean water-bearing soil, which facilitates fruit production. In the case of *El Rey del Desierto* (*Prosopis limensis*), this seasonal fluctuation in the availability of water may relate to presence or absence of thorns.

By honoring lessons of the past we can integrate them into a positive future. The ancient mesquites are here again to help navigate the task of feeding people under challenging conditions generated by climate change. *Prosopis*: the past is our present and future.

A BOUQUET OF DESERT FOOD PLANTS

ACANTH FAMILY – ACANTHACEAE

Justicia californica. Desert hummingbird-bush, *chuparosa*. Sweet nectar can be sucked from the flower base, mostly in spring, as a snack food.

AGAVE FAMILY – AGAVACEAE

Agave species including **A. deserti** and **A. palmeri**. Agaves served as major food resources and provided Native Americans with one of the few significant desert sweets. Plants showing signs of initiating a flowering stalk are selected, harvested, and trimmed to leave the centers as *cabezas* or "hearts," baked in coals in pit ovens, or thoroughly oven-baked in modern kitchens. Emerging flower stalks can also be pit-baked or cooked in coals. Raw, uncooked, agaves are highly toxic. Cooked agave hearts are sliced and eaten or formed into cakes or other

products that can be dried and stored. Juice from sweet, cooked agave hearts are made into alcoholic beverages, including tequila and mescal or *bacanora*.

Cooked flowers and seeds are also edible, but of minor significance. Agaves occur in nearly all Sonoran Desert mountains. Prehistoric people farmed selected agaves in rock mounds and terraces.

Agave leaf fiber was made into cordage, burden baskets, nets, and sandals. "Noiseless sandals" of agave fiber served for deer hunting. Rabbits were caught in nets sometimes 40 feet long and 3 feet wide. Leaves of some smaller species such as **Agave schottii,** shin dagger or *amolillo*, were mashed for shampoo and soap.

Yucca baccata. Banana yucca. Flowering occurs in late April and May and the fruits ripen in midsummer. The fruits were often pit-baked and flowers and seeds variously cooked and often stored. Full-sized green fruits are allowed to ripen indoors, become black like an overripe banana, and the custard-like fruit pulp eaten fresh. The dried plants, especially roots, can be made into soap and shampoo, and the leaves yielded cordage.

Yucca elata. Soaptree yucca. This tall yucca has slender, flexible leaves and tall flowering stalks. Young flower stalks, flowers, and sometimes the seeds serve as food. The leaves have been used as cordage, and the roots for soap and shampoo. The leaves are used in modern Tohono O'odham basketry.

PALM FAMILY – ARACACEAE

Washingtonia filifera. Desert fan palm. This is the only palm native to western U.S. It produces abundant, date-like small fruits with protein-rich seeds. The fruits can be made into beverages, preserves, and other date-like products. The fruits were harvested using a long pole. The related Mexican fan palm, *Washingtonia robusta*, has similar fruits but often not as sweet. Both are grown in warm climates worldwide.

The desert fan palm should be brought into agriculture in hot deserts. Although a high-water user, only a small area next to the trunk needs irrigating and wastewater and semisaline water are okay.

DAISY FAMILY – ASTERACEAE

Helianthus annuus. Sunflower. This large native annual is well known for its edible seeds. This widespread North American species is the progenitor of the commercial sunflower. Buffalo Birdwoman gives a Native American appreciation of the wild sunflower (Maxi'diwiac 1917).

Artemisia dracunculus. Wild tarragon and other closely related wild sages are small shrubs that are widespread across western North America. In 1935 Edward Castetter reported the "seeds were considered among the most important food plants when the Zuni reached this world." The tender, young foliage serves as a subtle culinary herb. It is a hardy easy-grower, suitable for home gardens and agronomic development. Commercial tarragon is an Old Word cultivar of *Artemisia dracunculus*.

CACTUS FAMILY – CACTACEAE

This essentially New World family includes 1865 species. Highest diversity is in semiarid subtropics near desert margins. The Sonoran Desert has 140 species. Most cactus fruits are variously edible, but not ones with dry spiny fruits. None are toxic, but be sure you know the difference between cacti and spiny plants in other families.

Columnar cacti.

The desert columnar cacti, especially *cardón*, saguaro, organpipe, and *pitaya agria*, produce delicious fruits. Eat the fruit fresh or dried, as preserves, syrup, or made into wine. The

small protein- and oil-rich seeds are digestible when the seed coat is broken. The seeds ground into buttery paste is better than peanut butter.

Carnegiea gigantea. Saguaro. The fruit rind splits open bright red like a flower although not edible. The juicy, red fruit pulp is sweet, slightly tart, and eaten fresh, dried, or cooked down into syrup, or made into wine to celebrate the Sonoran Desert New Year. Fruits ripen in May and June. Does anyone in Baja Arizona not know about saguaro fruit? Saguaro fruit with ice cream?

Stenocereus thurberi. Organpipe cactus, *pitaya dulce*. Flowering and fruiting mostly in early summer. The fruit skin is thin and edible and the minute seeds eaten together with the sweet fruit pulp. Wild-harvested fruits are seasonally sold in Sonora by street vendors and in local marketplaces. Organpipe should be developed as a premier desert orchard crop in regions of minimal freezing weather, for the fruit preserves and especially beverages including wine.

Stenocereus gummosus. *Pitaya agria*. This sprawling cactus grows on the Baja California Peninsula and the Seri Coast of Sonora. The razor-sharp spines are formidable. The sweet-tart fruit is one of the most delicious in the world.

Pachycereus pecten-aboriginum. *Etcho*. This columnar cactus occurs south of the desert in Sonora. The fruits have less pulp than those of the *cardón* but the seeds are much larger. The fruit pulp is made into preserves and the seeds ground into a grayish, buttery paste. To make a hairbrush the spines are removed from two-thirds of the fruit and the remaining spines trimmed to one centimeter.

Pachycereus pringlei. *Cardón*, *sagueso, sahueso*. This giant desert cactus is found in Sonora and the Baja California Peninsula. Ripe fruits have crimson-purple to pinkish white pulp, sweet and delicious. The seeds can be ground and salted as a buttery paste. Like the saguaro, you need a tall harvesting pole.

Other cacti.

Cylindropuntia. Chollas; *choya*. The Sonoran Desert is home to more than 30 cholla species and natural hybrids. Flower buds and young joints, or stem segments, of various larger chollas can be harvested in spring and cooked as vegetables. Fruits of the succulent-fruited species are eaten fresh or cooked (some cholla species have dry, inedible fruits). Chollas and prickly pears (*Opuntia*) are related and have large, bony "seeds" that are discarded. The spines and glochids (those small irritating spines) can be removed by several methods including brushing them in sand or soaking in water. Unlike most other cacti, cholla and prickly pear stems are not toxic.

Cylindropuntia acanthocarpa, buckhorn cholla; **Cylindropuntia echinocarpa**, silver cholla; **Cylindropuntia spinosior**, cane cholla. Flower buds of these and similar chollas, harvested in spring and often pit-baked, have been important food resources for desert people and continue to be a specialty food. Cholla buds can be prepared fresh or dried and stored. Pickled cholla buds are available in Tucson.

Various shrub-sized chollas have fleshy, edible fruits, especially **Cylindropuntia arbuscula**, pencil cholla, *siviri, tasajo*; **Cylindropuntia fulgida**, chain-fruit cholla; **Cylindropuntia spinosior**, cane cholla; and **Cylindropuntia versicolor**, staghorn cholla, *siviri*. The fleshy fruits, mostly available all year, can be eaten fresh or cooked and can be dried and stored. The fresh fruit is tart, somewhat sweet, pleasant-tasting and unique. The Seris harvest from *C. fulgida* with extra-large fruits. The fruits remain green and fleshy when ripe, or some such as *C. spinosior* are yellow. The thick fruit wall ("skin") is usually removed and the inner part eaten fresh, salted or plain. The fruits are also cooked in water and mashed and sometimes honey added for variety. Or the fruits are roasted in hot coals. Wooden tongs are used for harvesting.

Hard, dried, black gum that accumulates on cholla stems from injuries is edible and much appreciated by Seris and Yaquis. Variously called "cactus excrement," it can be ground, cleaned, and cooked, often with animal fat. The softer inner part can be eaten fresh. The dry gum can be

toasted or not, ground, and mixed with water and drunk as a beverage, often with honey or sugar. It is like a sweet pudding. The desert traveler would not be without food.

Cylindropuntia bigelovii. Teddybear cholla; *choya güera*, *ciribe*. Young stem segments, or joints, of this and certain other chollas were sometimes pit-roasted.

Echinocereus. Hedgehog cactus. Ripe fruits of most species are sweet and delicious, suitable for trail snacks. The spine clusters usually readily fall away from ripe fruits.

Ferocactus. Barrel cactus; *biznaga***.** Cooked buds and flowers of the larger, desert species such as *Ferocactus wislizeni* taste somewhat like Brussels sprouts. The seeds, rich in oil and protein, can be ground into a buttery paste. The fresh fruits are acidic or sour, with a strong lemon-like flavor. Take small portions from any one plant—leave plenty for the animals and reproduction.

Mammillaria, fishhook cactus, *cabeza de viejo*, including **Mammillaria grahamii**, Arizona fishhook cactus. The small, succulent and spineless fruits, red or orange when ripe, can be a tasty trail snack. *Mammillaria tetrancistra*, however, has an inedible corky-based fruit.

Opuntia engelmannii. Desert prickly pear; *nopal del desierto.* The large, juicy, purplish-red fruits, or *tunas*, which ripen in summer, are eaten fresh or dried, or made into juice, jam, or syrup. There is variation in taste and sweetness—find plants with superior-tasting fruits. Sonoran Desert people nurtured desirable selections and you can do the same. The young "pads" (stem segments) can be harvested in spring and summer, prepared and cooked as *nopales*. The buds and flowers can be prepared similar to that for chollas. This large prickly pear is distinguished by its large, green pads, flowers uniformly yellow, and fruits juicy and bright purplish red throughout.

HEMP FAMILY – CANNABACEAE

Celtis pallida. Desert hackberry. The small, orange, fleshy and slightly sweet fruits are eaten fresh, or as a snack food on the trail, or perhaps dried. Not everyone finds the fruit agreeable.

Celtis reticulata. Canyon hackberry. The small, rather hard, reddish fruits of this riparian tree can be variously prepared as a minor food.

LEGUME FAMILY – FABACEAE

People in the Sonoran Desert Region depended on wild-harvested and domesticated legumes such as tepary beans for food and many utilitarian uses. Beans, soy, and alfalfa are among the globally important legume crops.

Olneya tesota. Desert ironwood. The seeds, harvested in early summer, are one of the few Sonoran Desert foods cooked in changes of water. The seeds contain antinutrients, which is why leaching or soaking in water and repeatedly boiling is a good idea. The seeds, toasted and ground, can be prepared as *pinole*, or cakes, and often mixed with other foods such as palo verde flour. An infusion of the sapwood was drunk by the Seris as an emetic, to prevent breathing hard when running, and to obtain power during a vision quest. The extremely hard wood has been used in many ways, including as digging sticks with a fire-hardened point, fences, firewood, house posts, musical rasps, utensils, war clubs, and more recently as sculpture.

Parkinsonia florida [*Cercidium floridum*]. Blue palo verde. The seeds, available in early summer, are considered less desirable than those of *P. microphylla*, although prepared in essentially the same manner. Nevertheless, the seeds and sometimes the flowers and young green pods were eaten. The fresh, still green seeds serve as trail snacks. In cultivation the trees are often infested with a mite that results in deformed growth.

Parkinsonia microphylla [*Cercidium microphyllum*]. Foothill palo verde. The seeds, harvested in early summer, provided an important food resource. The hard and protein-rich seeds were parched, ground, and generally consumed as *atole*, and often stored. Western O'odham people baked the flour with deer fat and water to make a bread-like mass. The flour might be mixed with ironwood or mesquite flour. The flowers might be eaten fresh or best cooked, or very

young green pods cooked with meat. Fresh green seeds serve as snacks. This small tree seems like a winner for water-saving desert agriculture.

As with other palo verde species, the wood has been used for utensils, digging tools and pry bars, sculptures, and sometimes fuel.

OCOTILLO FAMILY – FOUQUIERIACEAE

Fouquieria splendens. Ocotillo. The tubular red flowers produce a bit of nectar that can be sucked from the flower base for a trailside snack. The flowers steeped in water provided a beverage for desert people. Nectar pressed from the flowers hardens when dry and was chewed as a delicacy. If you harvest the flowers be sure to leave plenty for the hummingbirds and seed production. Living fences are made from the stems, but the harvest, mostly from Texas, is not sustainable.

MINT FAMILY – LAMIACEAE

Salvia columbariae. Chia. This desert mint is a winter-spring annual. The small "seeds" (actually nutlets) were a significant desert food resource. Placed in water, the seeds become gelatinous and enjoyed as a beverage. The seeds can be parched and ground into flour, which can be stored. The seeds were have been widely used medicinally, especially to treat eye irritants and ailments. Desert chia is sometimes cultivated. It deserves wider consideration.

DEVIL'S CLAW FAMILY – MARTYNIACEAE

Proboscidea altheifolia. Desert devil's claw. The large tuberous roots is peeled and the outer portion (cortex) eaten fresh by the Seris. The very young, tender fruits of this species and *P. parviflora* can be cooked as a vegetable. The seeds are edible.

Proboscidea parviflora. Devil's claw. The seeds are casually eaten after the tough "husk" is peeled and discarded. A black strip in each long claw of the capsule is used in basketry. Wild plants have shorter claws and black seeds, whereas plants of the domesticated cultivar, grown in regional gardens and fields, have been selected for extra-long claws and have white seeds.

GRASS FAMILY – POACEAE

Civilization depends on a handful of grasses including barley, corn (maize), oats, rice, and wheat. Grasses generally have edible grain (grass fruit with a single seed), although many are not worth the trouble. However, grain infected with ergot can be deadly. People in the Southwest have harvested a broad spectrum of grasses as significant foods, even some with very small grain. Grama grasses, both annuals and perennials, are among those with grain that seems too small, but were practical because of their abundance. Gathered, threshed and winnowed, such grain would be parched or not, and variously cooked.

Distichlis palmeri. Nipa (the name, adapted from the Cocopah term, honors Cocopah knowledge). This hardy perennial saltgrass is native only to the upper Gulf of California. Its main homeland is the Colorado River Delta where it thrives on pure seawater in places of 10-meter tides. Nipa was a staple of the local Cocopah people and offers the world a rice-like grain for seawater irrigation, potentially significant in light of loss of the great lowland rice fields of the Orient by seawater intrusion due to global warming.

Sporobolus wrightii. Big sacaton. "Grass as tall as a horse's belly" is this one, growing along riverine floodplains and valley bottoms, where the foot trails went, the horse and wagon trails, and farmland and interstate highways. Still common in many places, this large, tough perennial thrives in semi-saline soils, producing prodigious quantities of gain. Grain so small it needs no milling, it is already fine like flour. A traditional Apaches staple, it holds promise as a major agronomic food crop. We have used the grain for bread, chips, and muffins. This drought-hardy, salt-tolerant grass is a winner.

Zuloagaea bulbosa [*Panicum bulbosum*]. Apache redgrass (aka bulb panicgrass). This large perennial grass grows in mountains above the desert. Apaches elders say it is the easiest to harvest and tastes the best, and we agree. The millet-like, gluten-free grain is easily separated from the chaff. It is also an attractive landscape plant. Apache elders approve "Apache redgrass," an approximation of their "red grass" name for the plant. The New Mexico Department of Agriculture is supporting our development of Apache redgrass as an agricultural crop.

NIGHTSHADE FAMILY – SOLANACEAE

This family includes chilies, eggplant, potatoes, and tomatoes, as well as *Datura* and tobacco.

Capsicum annum. Chiltepin. This wild chili is a small shrub ranging from southern Arizona to South America. The fiery hot small red fruits and seeds are a favorite among chili aficionados. Chiltepines are commonplace on tables of local Hispanic restaurants and in salsa. It is commercially wild harvested in Sonora and some farmers are cultivating it. Chiltepin is a perennial, unlike common, domesticated chilies. The *Capsicum* genus includes chili peppers and bell peppers.

Lycium fremontii. Desert wolfberry, desert goji berry. The fleshy-fruited desert wolfberry species, such as *L. andersonii*, have small, red-orange edible fruits. *Lycium fremontii* and the related *L. exsertum* produce abundant fruits, larger than those of other Sonoran Desert species and similar to goji berries (*Lycium barbarum* and *L. chinense*) of the Orient. *Lycium fremontii* and *L. exsertum* shrubs become laden with succulent fruits in early spring, although some shrubs produce only male flowers. The fruits are eaten fresh but especially cooked, often sweetened with sugar or honey, or dried like raisins. *Lycium fremontii* should be developed as a Baja Arizona agronomic crop.

VERBENA FAMILY – VERBENACEAE

Aloysia wrightii. Oreganillo. Leaves of this desert shrub have a mild oregano flavor, and can be used fresh or dried. Sonoran oregano, **Lippia palmeri**, related to *Aloysia*, is an esteemed condiment with a robust oregano flavor. It is commercially wild-harvested in Sonora and sometimes cultivated. Both are suitable for home gardens and worthy of agronomic development, although Sonoran oregano is frost-sensitive.

CALTROP FAMILY – ZYGOPHYLLACEAE

Larrea tridentata. Creosotebush, *hediondilla*. This shrub and a closely related one in South America circumscribe most of the New World deserts. *Larrea* is rich in aromatic terpenes—*The Desert Smells Like Rain* is creosotebush after a rain. It is the premier Sonoran Desert medicinal plant. Although the flower buds might be pickled as capers and the flowers used to flavor beer, you should investigate it with caution. The leaves can be toxic and are not a food source.

SELECTED REFERENCES

Burkart, Arturo E. 1976. A monograph of the genus *Prosopis*: (Leguminosae Subfam. Mimosoideae). Journal of the Arnold Arboretum 57: 217–249, 450–525.

Dobrizhoffer, Martín. 1822. An Account of the Abipones, An Equestrian People of Paraguay, Vol. 3. John Murray, London.

Felger, Richard Stephen. 2007. Living resources at the center of the Sonoran Desert: Native American plant and animal utilization. Pages 147–192 *in* Felger & Bill Broyles, editors, *Dry Borders: Great Natural Reserves of the Sonoran Desert*. University of Utah Press, Salt Lake City.

Felger, Richard Stephen and Mary Beck Moser. 1985, reprinted 1991, e-book 2016. *People of the Desert and Sea: Ethnobotany of the Seri Indians*. University of Arizona Press, Tucson.

Greenop, Rosanna, Gavin L. Foster, Paul A. Wilson, and Caroline H. Lear. 2014. Middle Miocene climate instability associated with high-amplitude CO_2 variability. Paleoceanography 29: 845–853. (doi:10.1002/2014PA002653).

Hodgson, Wendy C. 2000. *Food Plants of the Sonoran Desert*. University of Arizona Press.

Kirk, Donald R. 1970. *Wild Edible Plants of Western North America*. Naturegraph Publishers, Happy Camp, CA.

Maxi'diwiac (Buffalo Bird Woman). 1917. *Buffalo Bird Woman's Garden*, edited by Gilbert Livingstone Wilson as "*Agriculture of the Hidatsa Indians: An Indian Interpretation.*" PhD dissertation, University of Minnesota, Minneapolis.

Nabhan, Gary Paul. 1982. *The Desert Smells Like Rain: A Naturalist in Papago Indian Country*. North Point Press, San Francisco.

Nabhan, Gary Paul. 1986. *Gathering the Desert*. University of Arizona Press.

Pearlstein, S.L., Felger, E.P. Glenn, J. Harrington, K.A. Al-Ghanemd, and S.G. Nelson. 2012. Nipa (*Distichlis palmeri*): A perennial grain crop for saltwater irrigation. *Journal of Arid Environments* 82: 60–70.

Rea, Amadeo. 1997. *At the Desert's Green Edge: An Ethnobotany of the Gila River Pima*. University of Arizona Press.