

Cacti: A Brief Introduction & Cacti of Joshua Tree National Park

Desert Institute Fall 2023

Master Gardeners 26 Oct 2023

Melanie Davis

melanie.davis@ucr.edu



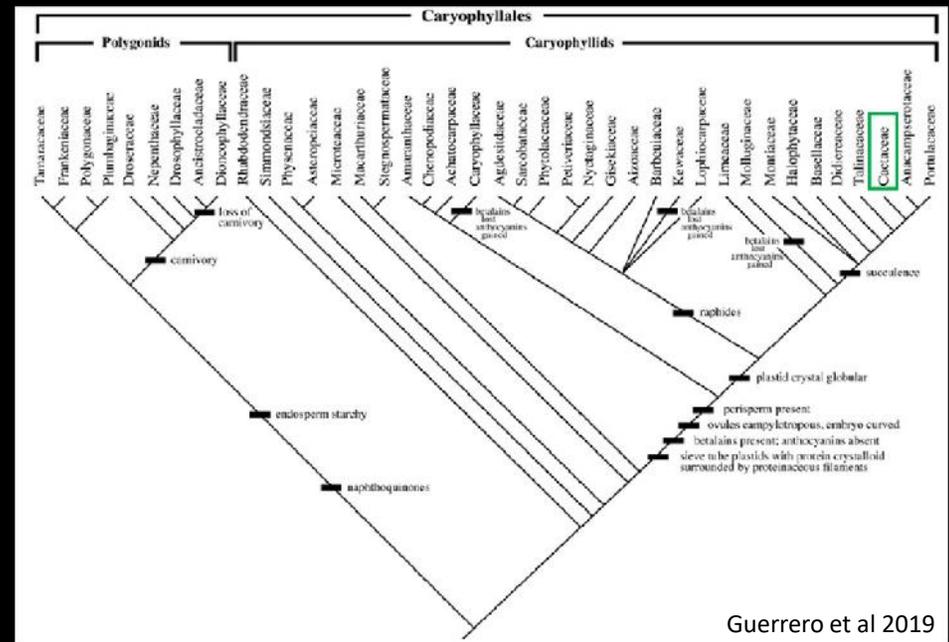
Talk Outline

- Botany: Ecological and Taxonomical definitions of Cacti and Cactaceae
- Range, Human, and Animal interaction
- *IF TIME*: Introduce Cacti species within JTNP
- Questions/Discussion



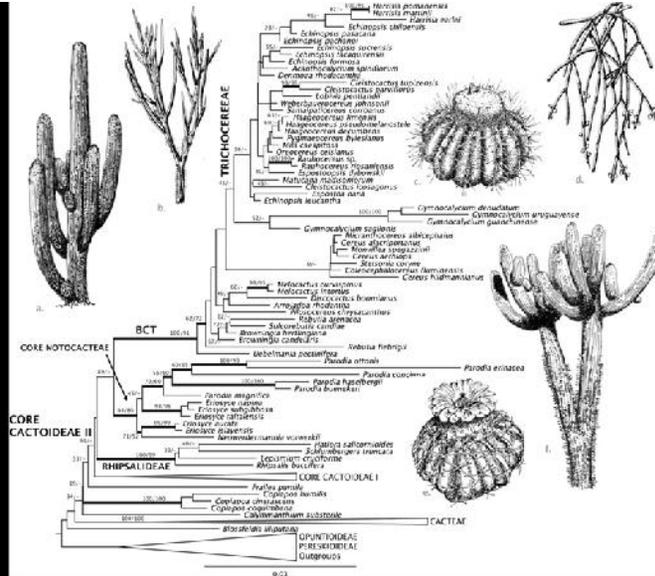
What Are Cacti: Caryophylls

- Of the order Caryophylls
 - Include 37 families
 - Occur Worldwide
 - Contain Betalains – chemical that produces bright yellow and red pigments



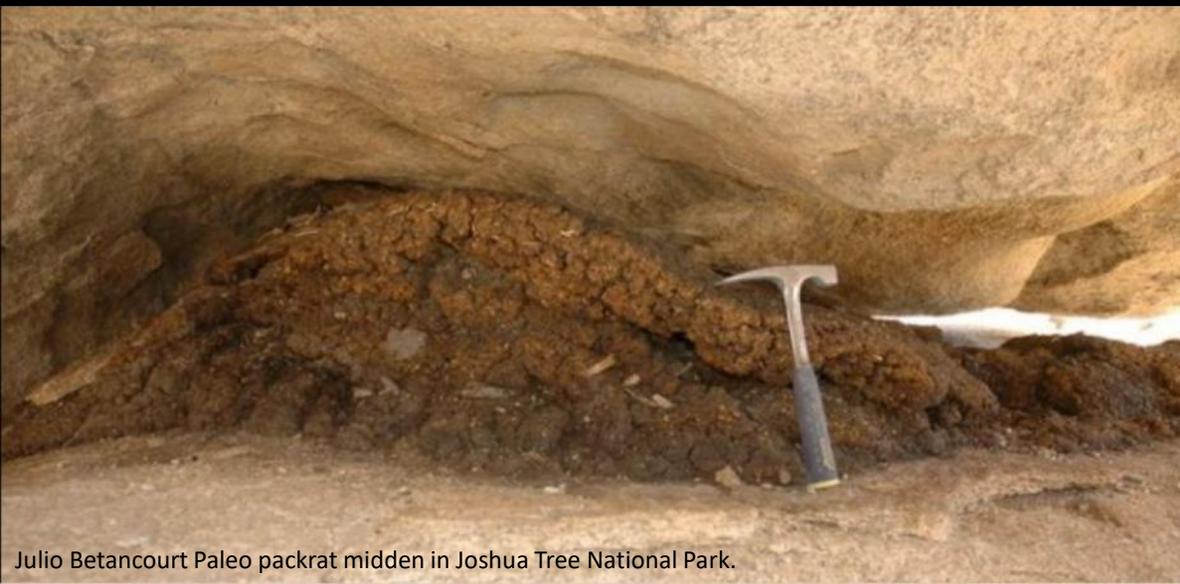


Pereskia sacharosa



What Are Cacti: Cactaceae

- Of the Family Cactaceae: 4 Subfamilies, 151 genera, 1855 species – highly diverse & relatively young!
 - Pereskioideaea (South America & the Carribean)
 - Maihuenioideae (2 species, Chile and Argentina)
 - **Cactoideae** (>80% of family; N. & S. America)
 - **Opuntioideae** (N. & S. America)
- Originated in the late Jurassic 35-65 mya in South America (Central Andes being the hotspot)
 - Dating is difficult due to a lack of fossil record (climate and tissue)
 - Some estimates have been made about recent evolution by carbon dating spines found in pack rat middens (~25,000 years)
 - Due to limited distribution in New World, this family must have evolved after Pangea split
 - Current dating relying on phylogenetics and studying ancient climatic changes



Julio Betancourt Paleo packrat midden in Joshua Tree National Park.



Pelecephora alversonii



Cylindropuntia ramosissima



Opuntia basilaris

What Are Cacti: Cactaceae Distinguishing Features

- Generally have spines – modified leaves
- Have Areoles
 - Areole: A specialized spot (technically a modified stem) on a cactus stem that can produce spines, bristles, glochids, hairs, flowers, roots, or even new stems
- Leaves absent, if present reduced or deciduous
- Sometimes have ribs or tubercles
 - Tubercles are raised bumps that are formed by the fusion of a leaf petiole with stem tissue



Ferocactus emoryi



Cylindropuntia echinocarpa

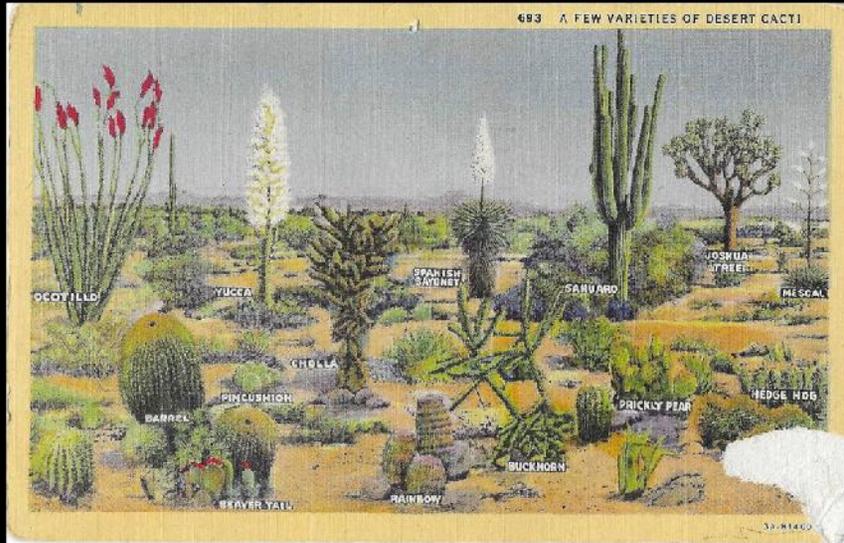


Stenocereus thurberi & *Trichocereus schottii*

What Are Cacti: Cactaceae Distinguishing Features

- Typically stem succulent
 - Serves as water storage within inner tissue where it can be accessed during drought
 - Enables them to survive water losses up to 90%
 - Waxy cuticle on epidermis and slimy mucilage in interior cell allows water retention
 - Tubercles and ribs expand to accommodate water uptake

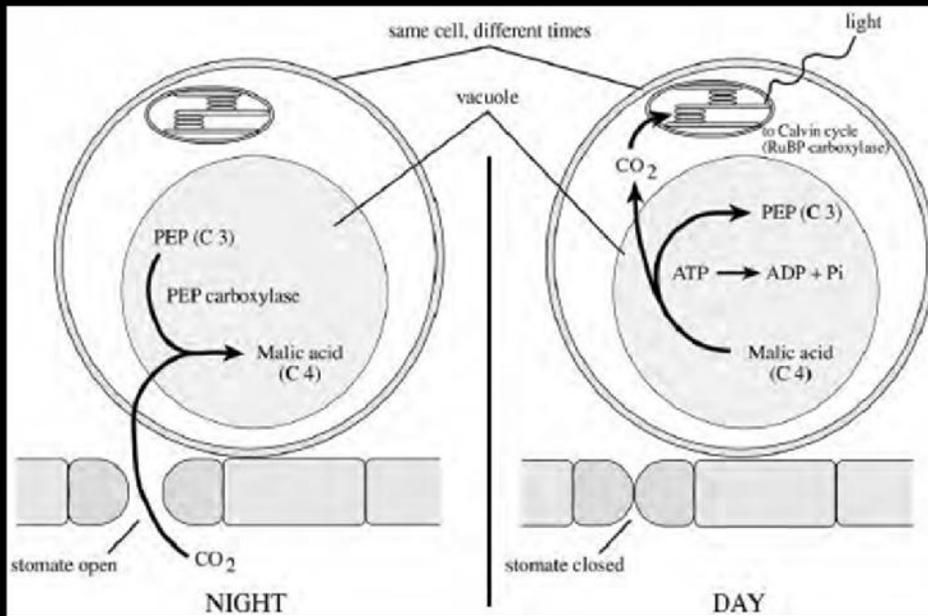
Succulence & Cacti



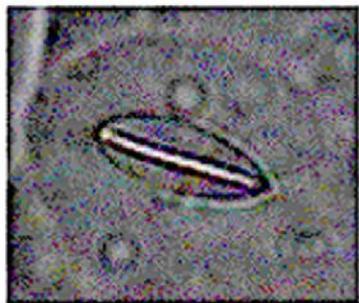
Dudleya arizonica & *Echinocereus engelmannii*

- All Cacti are succulents, but not all succulents are cacti
- Cacti are members of the Cactaceae family. 'Succulent' is a descriptor and can be found in many families
- Succulent Traits:
 - Leaves, stems, and sometimes roots can be adapted for water storage
 - Often cylindrical and spherical leaves (low surface area to volume ratio)
 - Succulence prominent in other families: Euphorbiaceae, Orchidaceae, Asparagaceae (Yuccas!), Crassulacea (Dudleya!)..... And many more!
 - CAM photosynthesis
- Convergent evolution – distantly related organisms independently evolve similar traits due to similar environments

What Are Cacti: Cactaceae Distinguishing Features



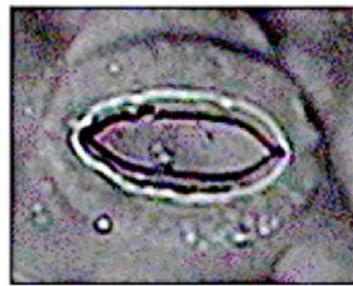
- Use CAM (Crassulacean acid metabolism) photosynthesis
 - Common in succulents
 - Plants conserve water by closing their stomata during the day and only open them at night for gas exchange.
 - CO₂ converted to malic acid for storage, then converted back into CO₂ during the day to complete photosynthesis
 - Named after the stonecrop/dudleya family – Crassulaceae, another commonly succulent family across arid habitats



closed



partially open



open



Dudleya arizonicus



Yucca schidigera



Echinocereus engelmannii



Cochemitea tetrandistra

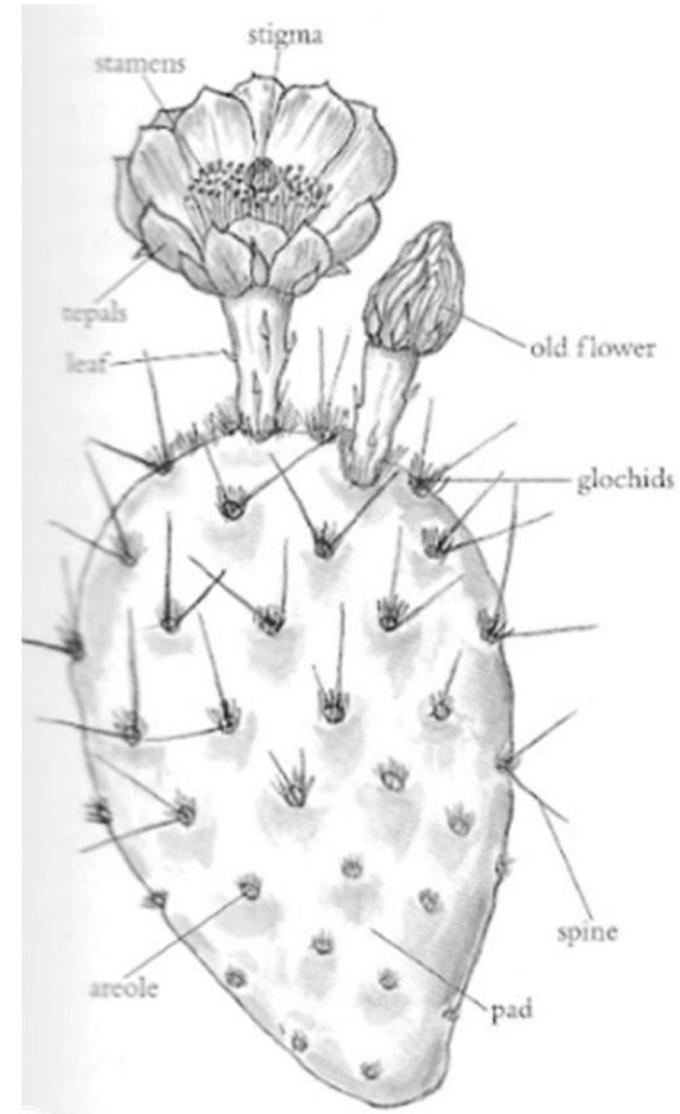
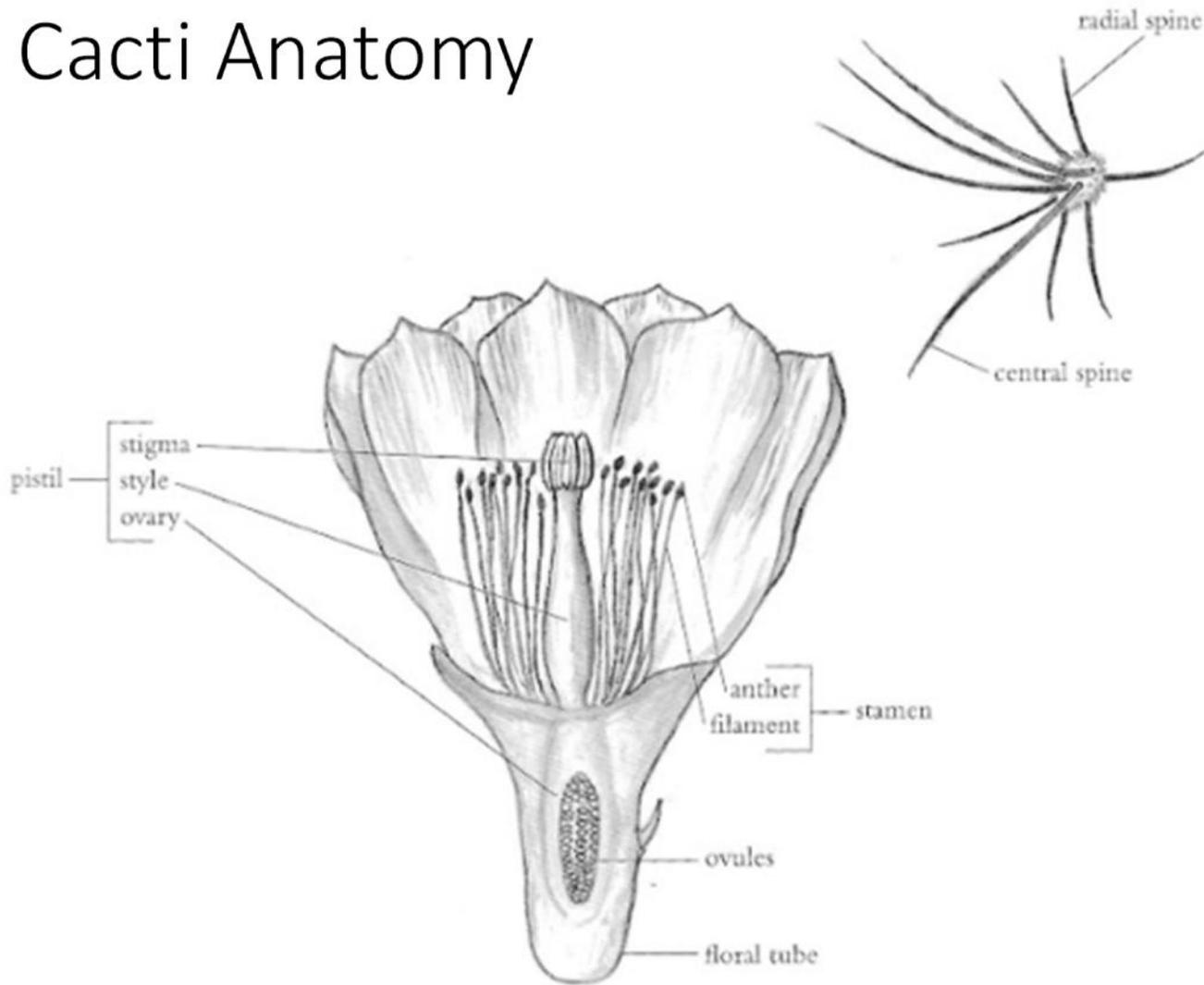
What Are Cacti: Cactaceae Distinguishing Features

- Flowers in spiral shape, numerous stamens
- Inferior ovary – located below the flower parts and sunken into the stem tissue
- Outer tissue of fruit is essentially stem tissue – often covered in areoles that can produce spines, or even roots that aid in asexual reproduction

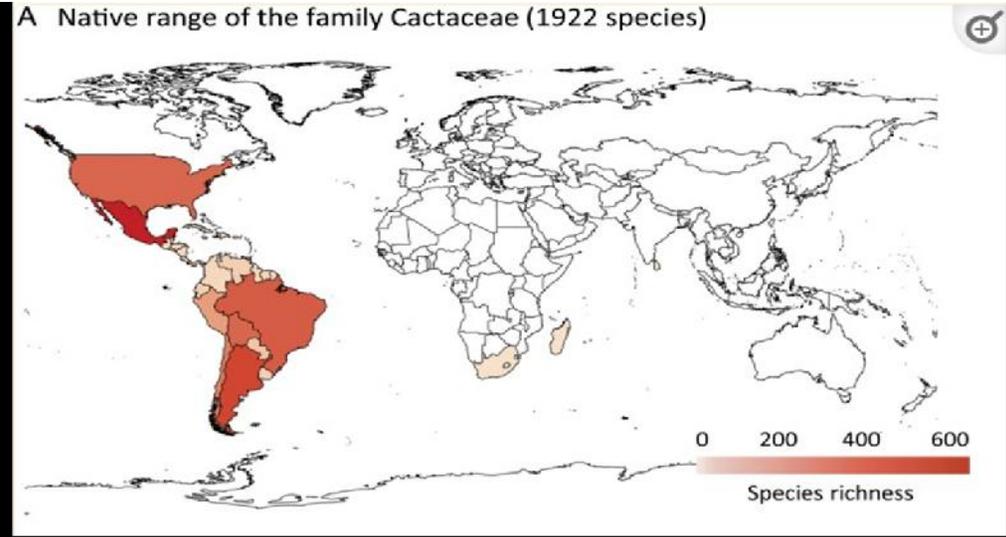


Rosas-Reinhold et al. 2021

Cacti Anatomy



Prickly-pear pad, dissected flower, and spine detail. Illustration by Susan Bazell.

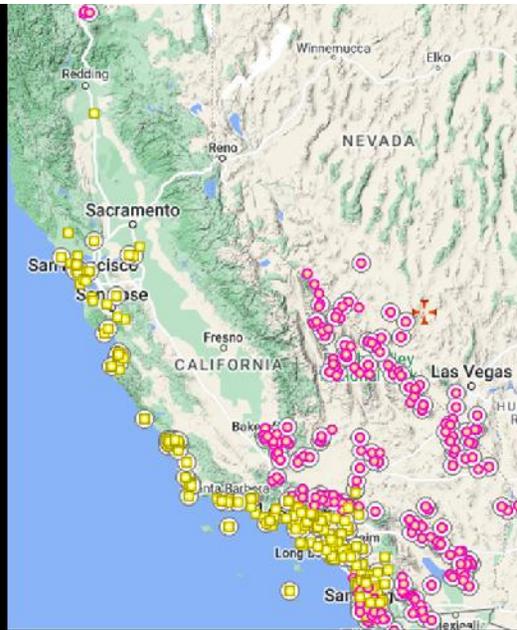
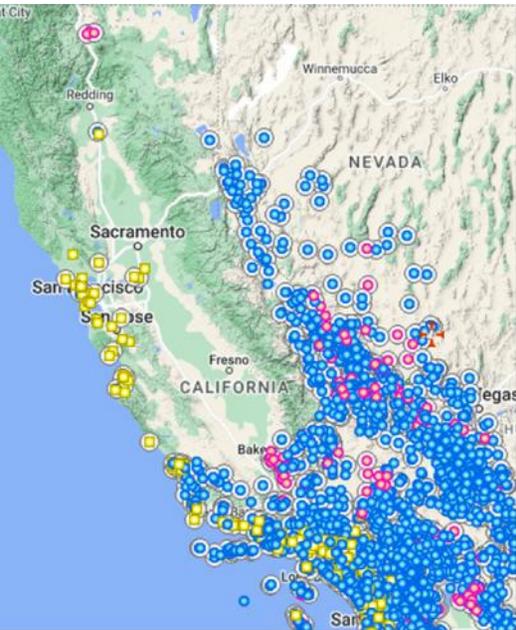


Steenderen 2020



Where Do We Find Cacti?

- Native range: Found from central Canada to Patagonia in southern Argentina
- One bird dispersed species, *Rhipsalis baccifera*, is a tree dwelling (epiphytic) cacti and occurs in southern Africa as well as Madagascar and other Indian Ocean islands (and apparently in Sri Lanka)



Where Do We Find Cacti In California?

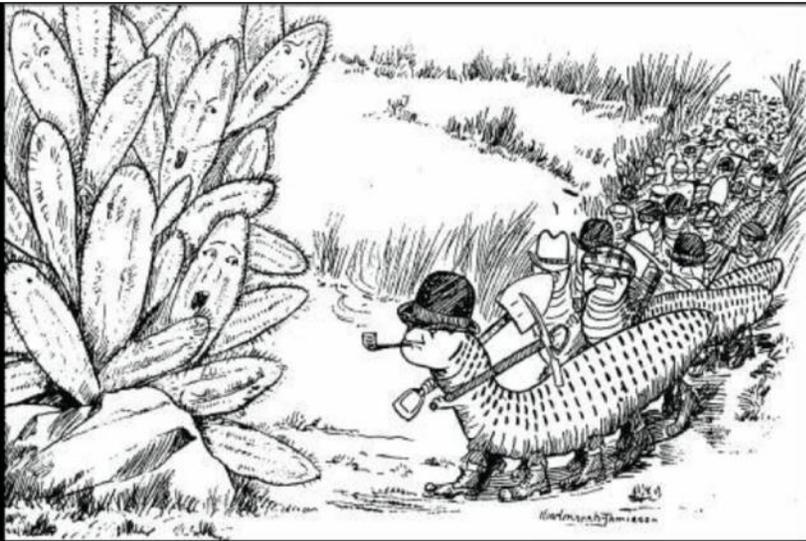
- In California:
 - We have 12 genera with a total of 38 recognized species, 20 of which are considered Rare by the California Native Plant Society (~53%!)
 - Species range all the way from the California/Mexico Border to Mount Shasta
 - California Cacti are primarily found in the deserts
 - Still taxonomic uncertainty within the family, numbers are constantly changing with advances in phylogenetics
 - California is the most botanically diverse state in the US – due to complex geology, topography, tectonic activity, and latitudinal range
 - Invasive cacti in CA: 5 *Opuntia* species, primarily *Opuntia ficus-indica* (Tuna) – horticulture escapee



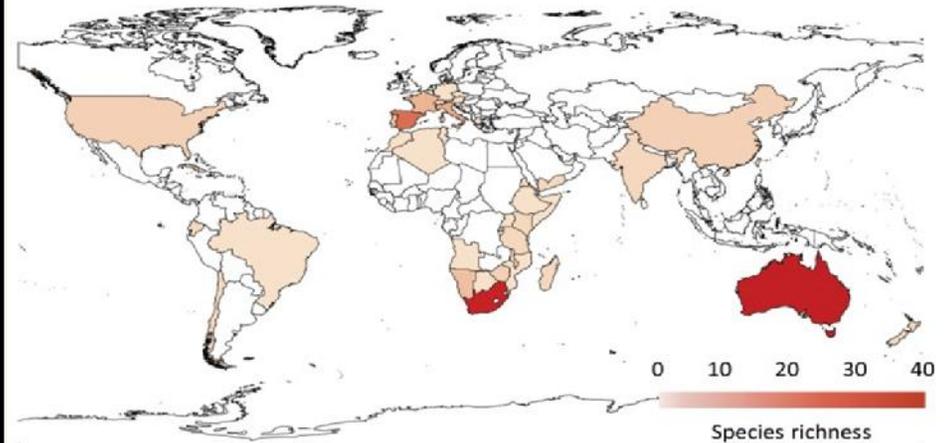
Opuntia fragilis



Opuntia ficus-indica



B Invasive range of the 57 invasive cactus species



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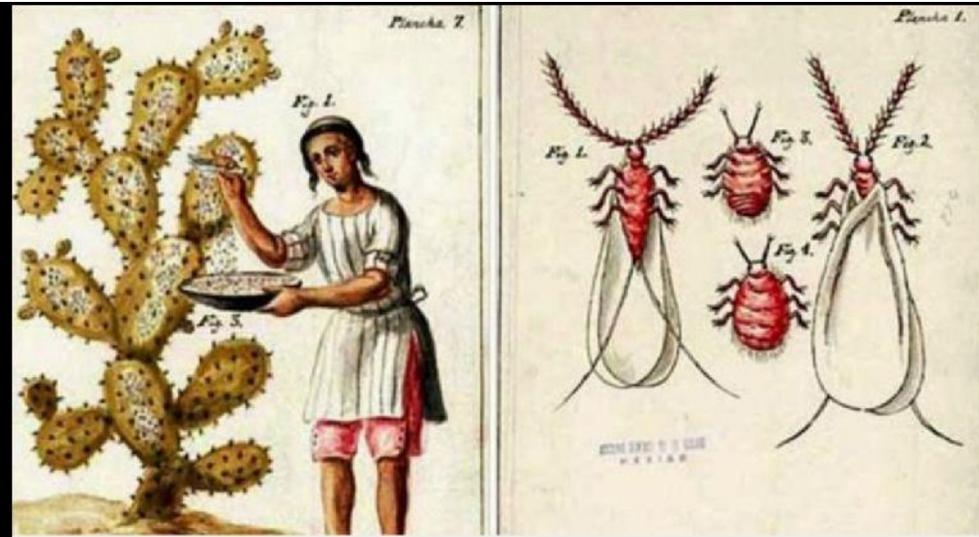
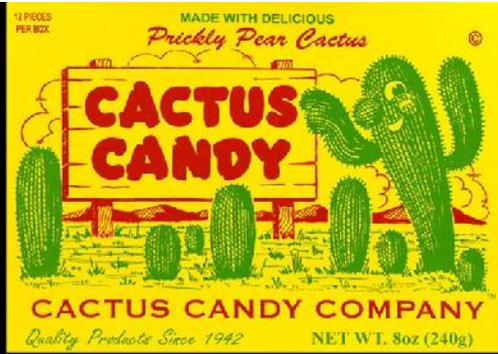
World Wide Invasion

- World Wide – While Cacti are only native to North America, they have become introduced, naturalized, and even invasive across the Globe
- 57 species have been assessed as invasive
- South Africa, Australia, and Spain are the hotspots of global invasion
- Biological control (cactus moth – *Cactoblastis cactorum*, native to South America) has been used to eradicate where it is invasive, however it is now spreading west and could have devastating consequences within native ranges.



Opuntia in AUS





Cacti & Humans

- Humans have had close relationships to cacti for ~12,000 years
- Cacti continue to be harvested from the wild and cultivated for a wide range of uses with an annual economic value of >\$80 million
 - Food – Humans & Livestock: Stems (nopales), Buds, Fruit
 - Ornamental – Landscaping and personal collections
 - Cochenial dye (scale insect *Dactylopius coccus*)
 - Living Fences
 - Drugs –pharmaceutical, religious, and recreational



L.Sweet 2017



L.Sweet 2023

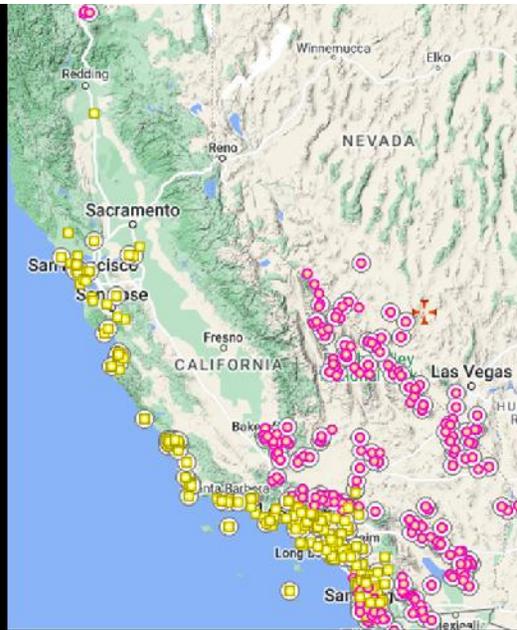
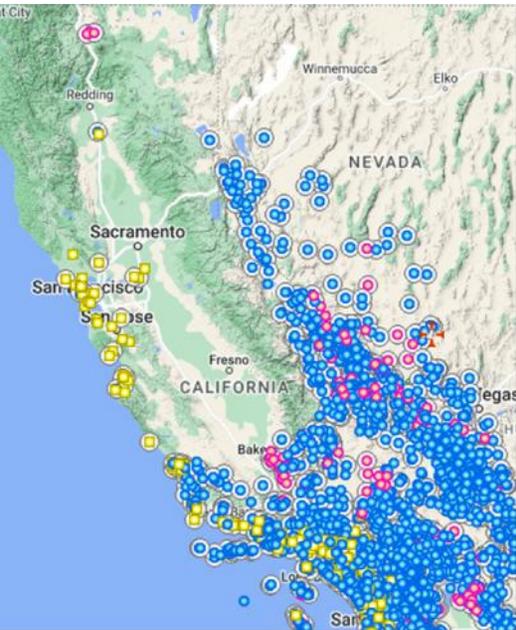


Cima Dome Fire 2020

Range Wide Threats

~31% of all cacti species are considered endangered (ICUN, NatureServe)

- **Poaching**
 - Multi-million dollar business
 - For landscaping
 - Rare species for private collectors
 - Species associated with drugs
- **Habitat fragmentation and destruction**
 - 50% of cacti have ranges <10,000 km²
 - >300 species with ranges <2,000 km²
- Cactus moth – *Cactoblastis cactorum*
- Climate change
- Invasive species
- Fire
- Grazing and herbivory with drought



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 - Invasive cacti in CA: 5 *Opuntia* species, primarily *Opuntia ficus-indica* (Tuna) – horticulture escapee



Opuntia fragilis



Opuntia ficus-indica



L.Sweet 2017



L.Sweet 2023



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Cacti Pollination & Animal Interactions

- Animals rely on cacti for food, protection, and height for hunting, among other ecological benefits
 - Cactus wrens and Leconte's thrashers build their nests inside of dense cacti (like cholla), shrikes will use spines for their 'pantries'
 - Harris's hawks and owls use for hunting and nesting
 - Packrats use cholla segments in their middens

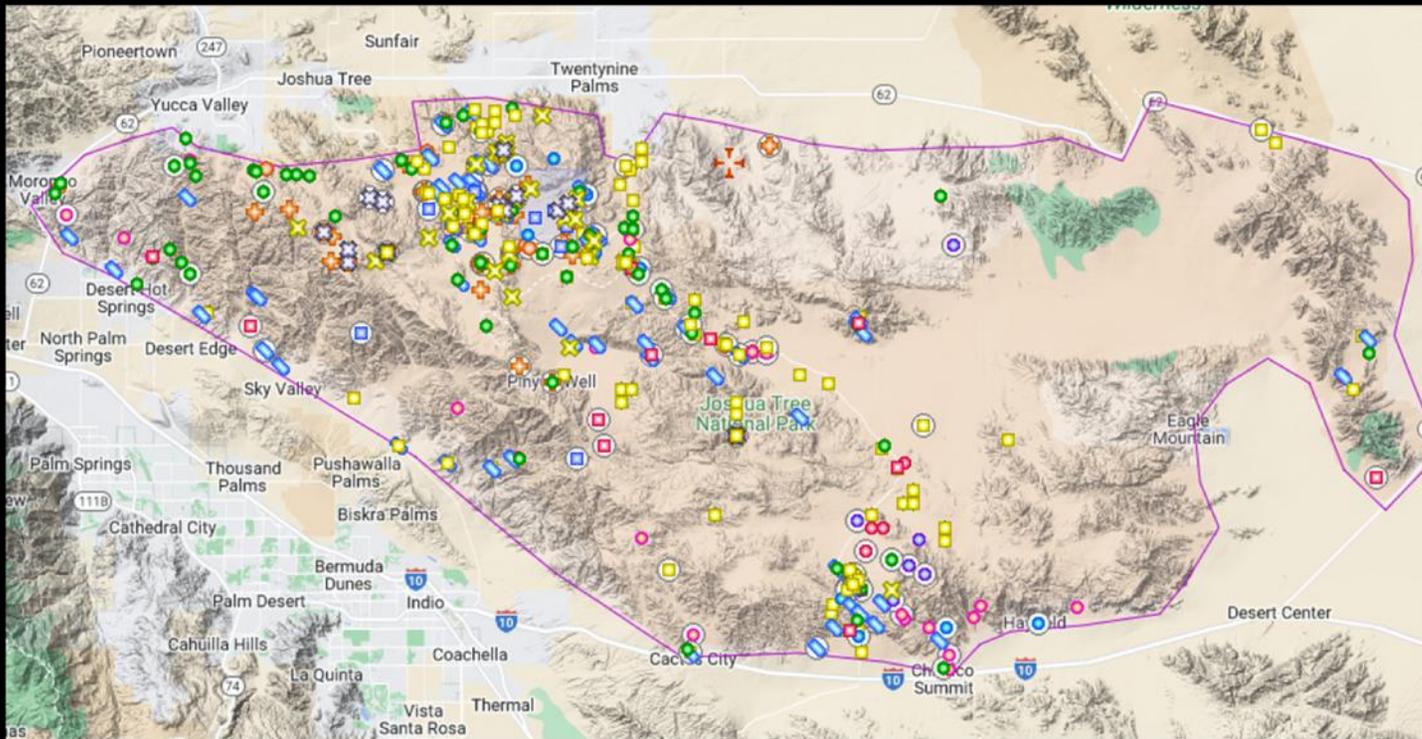


Cacti Pollination & Animal Interactions

- As with most flowering plants, pollination is key for the survival of the species. While many cacti species can reproduce asexually, most rely on pollinators for sexual reproduction
- Major pollinators:
 - Insects – ants, flies, bees, beetles, moths etc. etc
 - Bats
 - Birds



Cacti of Joshua Tree National Park!



- We have 15 species of cacti within the park boundaries (8 genera)
- 2 (should be 3) of which are considered Rare (CNPS)
- Occupy low to high elevations across all habitat types
- Blank areas on distribution maps likely due to under-accessed

Cacti of Joshua Tree National Park!

- Split into two (non-technical) groups: Segmented and Non-Segmented
- This is defined by if the stem is broken into stem segments, or if the individual is columnar or having all segments come from the base.
- Stem sprouting is an exception, joins must be consistent



	GENUS	SPECIES	NAME
SEGMENTED CACTI	<i>Cylindropuntia</i>	<i>bigelovii</i>	Teddy-bear cholla
		<i>chuckwallensis</i> *	Chucky cholla
		<i>echinocarpa</i>	Silver cholla
		<i>ramosissima</i>	Pencil cholla
	<i>Grusonia</i>	<i>parishii</i> *	Club cholla
	<i>Opuntia</i>	<i>basilaris</i> var. <i>basilaris</i>	Beavetail cactus
		<i>chlorotica</i>	Pancake prickly pear
<i>phaeacantha</i>		Brown-spined prickly pear	
<i>polyacantha</i> var. <i>erinacea</i>		Grizzly bear cactus	
NON-SEGMENTED CACTI	<i>Cochemiea</i>	<i>tetrancistra</i>	Nipple cactus
	<i>Echinocereus</i>	<i>engelmannii</i> var. <i>engelmannii</i>	Hedgehog cactus
		<i>mojavensis</i>	Mojave mound cactus
	<i>Ferocactus</i>	<i>acanthodes</i>	Barrel cactus
	<i>Homalocephala</i>	<i>polycephala</i>	Cotton top
	<i>Pelecyphora</i>	<i>alversonii</i> *	Foxtail cactus

Segmented Cacti of Joshua Tree National Park

***Cylindropuntia* (Cholla)**

- 4 species in JTNP (12 described in CA)
- Pad segments cylindrical
- Spine sheath papery and persisting
- Easily detachable stem segments
- Tubercled
- Fruit often with spines



***Grusonia* (Club cholla)**

- 1 species in JTNP (1 in CA)
- Pad segments club shaped
- Papery sheath only on spine tip and often not present
- Low growing
- Tubercled
- Fruit dry and spiny



***Opuntia* (Prickly pear)**

- 4 species in JTNP (~9 in CA, infinite hybrids)
- Pad segments are round and flat
- No spine sheath
- Stems not generally easy to detach
- Generally not tubercled
- Fruit often spineless and fleshy



Non-Segmented Cacti of Joshua Tree National Park

- 5 genera (6 species) in JTNP – 7 genera, 15 species in California
- Cylindrical
- Ribs and tubercles for contraction with water storage
- No glochids

NON-SEGMENTED CACTI	<i>Cochemiea</i>	<i>tetrancistra</i>	Nipple cactus
	<i>Echinocereus</i>	<i>engelmannii</i> var. <i>engelmannii</i>	Hedgehog cactus
		<i>mojavensis</i>	Mojave mound cactus
	<i>Ferocactus</i>	<i>acanthodes</i>	Barrel cactus
	<i>Homalocephala</i>	<i>polycephala</i>	Cotton top
	<i>Pelecyphora</i>	<i>alversonii</i> *	Foxtail cactus





Cacti Species of Joshua Tree

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Segmented Cacti: *Cylindropuntia*

Cylindropuntia bigelovii – Teddybear Cholla

- Found in the eastern Mojave and Sonoran deserts, down to Baja on rocky bajadas and gravelly slopes to flats
- Single, occasionally forked main trunk
- Stems: short, thick. Lower trunk dark brown fading to light green. Segments are notorious for detaching
- Spines: densely on branch, thin and yellow
- Flower Color: Pale yellow with reddish tips and green filaments
- Fruit: bright yellow, usually sterile, becomes spineless with age
- Most individuals are triploid (33 chromosomes), therefore do not easily reproduce sexually.
- Stands are clonal
- Famous Cholla Cactus Garden





Segmented : *Cylindropuntia*

Cylindropuntia chuckwallensis– Chucky Cholla

- Narrow Endemic - Found on the 29 Palm Marina Base, Southern JTNP, Chuckwalla and Chocolate Mountains on rocky soils
- Low growing with short branches, many per node
- Spines: Thin & white
- Flower Color: yellow to orange to dark red, with pink to red filaments and styles
- Currently considered but rejected for a Rare Plant Rank, however populations are in decline due to effects of climate change and should be re-evaluated
- Recently described (Baker & Could-Hughes 2014)





Segmented Cacti: *Cylindropuntia*

Cylindropuntia echinocarpa– Silver/Golden Cholla

- Common - Found in Mojave and Western Sonoran deserts
- More erect than *C. chuckwallensis*
- Stems: firmly attached
- Spines: white, gold, sometimes pinkish. Sheaths baggy and white to yellow with golden tips
- Flower Color: yellow-green, sometimes with a slight orange tint. Filaments yellow-green
- Fruit: dry, brown, and spiny. Easily detached with a bare bottom
- Easily hybridizes with other CA species.
- Previously described *C. wigginsii* is just a juvenile *C. echinocarpa*





Segmented Cacti: *Cylindropuntia*

Cylindropuntia ramosissima– Pencil/Diamond Cholla

- Common - Found in Mojave and Sonoran deserts to NE Baja/NW Sonora
- Sprawling shrubs to arborescent
- Stems <1cm in diameter, sometimes purplish
- Spines: 0-1 per areole, various colors, sheaths baggy and often golden-tipped
- Flower Color: pale yellow to rose-pink, filaments short, greenish
- Fruit: Dry and densely short-spiny, bur-like





Segmented Cacti: *Grusonia*

Grusonia parishii– Club Cholla

- *Grusonia* are defined as cacti with clavate (club-shaped), jointed stems, spines are flattened, plant growing in low mats <20cm tall to several meters wide.
- Only *Grusonia* species in California also occurs within the Park, with a CNPS Rare Plant Rank of 2B.2
- Found within the Joshua Tree/Landers area and Mojave National Preserve on sandy/gravelly flats
- Spines: grey to red to brown with white margin. Spine sheath only present at tip and falls away early
- Flower Color: yellow to pink
- Fruit: obconic, yellow, with dense glochids and some spines





Segmented Cacti: *Opuntia*

Opuntia basilaris var. *basilaris* – Beavertail Cactus

- Common - Found throughout the Mojave, extending to the Great Basin and northern Sonoran deserts
- <0.5 m tall, pads generally obovate and blue-grey
- No spines, however many glochids per areole – incredibly irritating!
- Flower Color: Highlighter magenta/pink
- Fruit: glochid covered, green and purple
- The other two subspecies within CA are *O. b. ssp. treleasei* (rare and federally endangered, occurs outside of Bakersfield on the edge of the Tehachapi mts) and *O. b. ssp. brachyclada* (chaparral and oak-pine woodland in Transverse ranges to Big Bear)

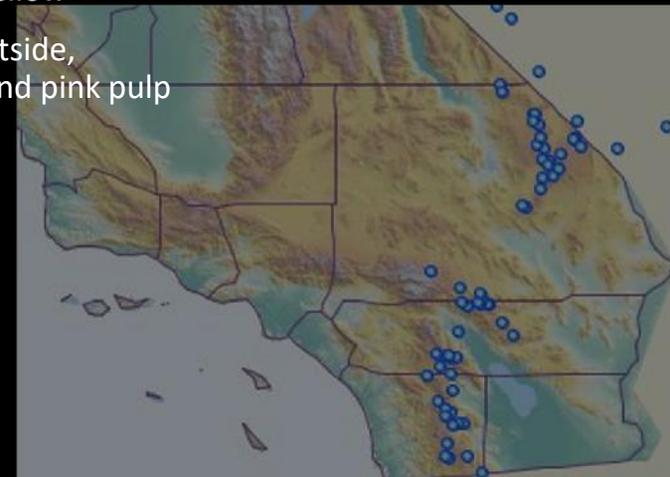




Segmented Cacti: *Opuntia*

Opuntia chlorotica – Pancake Prickly Pear

- Found in Mojave, Anza area (eastern SD county) out to southern New Mexico, generally within desert mountains on rocky slopes.
- Arborescent (tree-like), up to 2 meters tall, with a distinct spined trunk
- Pads are perfectly circular and jointed at a 90° angle
- Spines: short, thin, yellow, and pointing downward
- Flower Color: Yellow
- Fruit: purple outside, white interior and pink pulp





Segmented Cacti: *Opuntia*

Opuntia phaeacantha – Brown-Spined Prickly Pear

- Found in Mojave, desert and coastal arid mountains
- Sprawling and close to the ground
- Pads are grey-green and more oval/obovate
- Spines: Multicolored, flat and spreading
- Flower Color: Yellow with red at the base
- Fruit: fleshy/juicy, green or red-purple
- Commonly mis-identified with *O. engelmannii* as both species have variable forms and research is needed for genetic resolution.





Segmented Cacti: *Opuntia*

Opuntia polyacantha var. *erinaceae* – Grizzlybear Prickly Pear

- Found in Joshua tree and pinyon-juniper woodlands 900-2200 m elevation from the Anza desert, Mojave, and Great Basin
- Spreading low to ground with upright pads
- Pads narrowly oval
- Appear hair-like, thin, white to pale yellow that become denser, longer and more downward-pointing towards the base
- Flower Color: pale yellow with green stigmas
- Fruit: dry with long spines
- Often less spiny at higher elevations



Non-Segmented Cacti of Joshua Tree National Park

- 5 genera (6 species) in JTNP – 7 genera, 15 species in California
- Cylindrical
- Ribs and tubercles for contraction with water storage
- No glochids

NON-SEGMENTED CACTI	<i>Cochemiea</i>	<i>tetrancistra</i>	Nipple cactus
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	<i>Pelecyphora</i>	<i>alversonii</i> *	Foxtail cactus

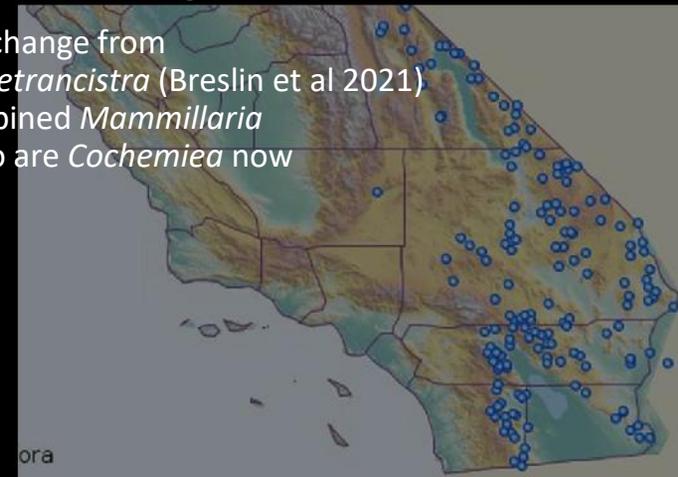




Non-Segmented Cacti: *Cochemiea* (prev. *Mammillaria*)

Cochemiea tetrancistra – Fish Hook/Nipple Cactus

- Mojave and Sonoran deserts within various habitats, often rocky
- Stems cylindrical and spongy, usually single. Up to 25 cm tall
- Spines: Central spines are 3-4 per areole, at least one long hooked spine per areole, tips dark. Radial spines 30-60
- Flower Color: pale to bright pink
- Fruit: Long to Ovoid and bright red
- Recent name change from *Mammillaria tetrancistra* (Breslin et al 2021)
– All hooked spined *Mammillaria* west of El Paso are *Cochemiea* now

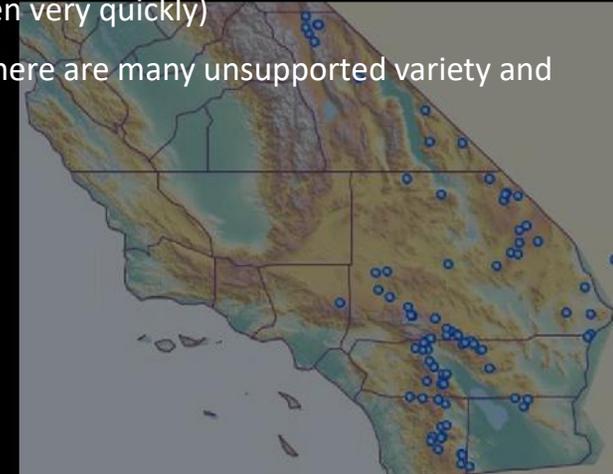




Non-Segmented Cacti: *Echinocereus*

Echinocereus engelmannii ssp. *engelmannii* – Hedgehog Cactus

- Common – ranges from lower Great Basin, to Mojave and Sonoran deserts, down through Baja. Often found in rocky areas
- Upright stems up to 45cm tall
- Spines: 15-20 per areole, variable
- Flower Color: Large & Magenta with green stigmas
- Fruit: large, spherical and red, densely spiny and popular with desert critters (eaten very quickly)
- Due to variability, there are many unsupported variety and subspecies names





Non-Segmented Cacti: *Echinocereus*

Echinocereus mojavensis – Mojave Mound Cactus

- Wide ranging within the Mojave desert.
- Stems create a dense mound that can reach a meter (or greater!), containing up to 500 stems!
- Spines: 3-11 per areole, twisted and somewhat curved, gray
- Flower Color: Bright orange-red
- Fruit: Spherical with small spines
- Often listed (as on iNaturalist) as *Echinocereus triglochidiatus* ssp. *mojavensis*.





Non-Segmented Cacti: *Ferocactus*

Ferocactus acanthodes (prev. *cylindraceus*) – Barrel Cactus

- Common on southern slopes in the Sonoran (Colorado) and Eastern Mojave Deserts
- Generally single cylindrical stem, although occasionally in clumps
- Spines: 10-32, erect and spreading with the longest spine hooked. Note the distinct transverse ridges on spines (*H. polycephla* ssp. *polycephla* less so)
- Flower Color: Bright orange-red
- Fruit: Spherical with small spines
- Often listed (as on iNaturalist) as *Echinocereus triglochidiatus* ssp. *mojavensis*.





Non-Segmented Cacti: *Homalocephala* (prev. *Echinocactus*)

Homalocephala polycephala ssp. *polycephala* – Cottontop

- Found in the eastern Mojave and Sonoran deserts, rocky hillsides
- Big, round spherical stems up to 50cm in diameter, occur in mounds up to a meter wide
- Spines: 10-19 per areole, flat, curved, usually red but occasionally yellow
- Flower: yellow
- Fruit: encased in dense woolly hairs
- Young with single head and difficult to distinguish from *Ferocactus acanthodes*
- Previously known as *Echinocactus polycephalus* var. *polycephalus* (Vargas-Luna et al. 2018)

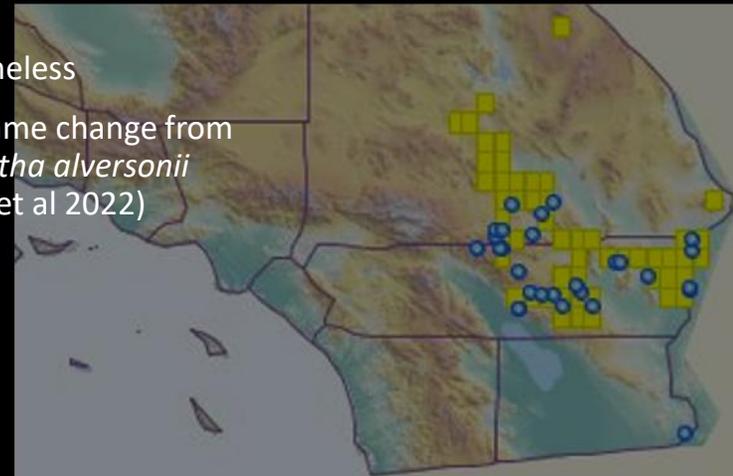




Non-Segmented Cacti: *Pelecyphora* (prev. *Coryphantha*)

Pelecyphora alversonii – Foxtail Cactus

- California endemic, CNPS Rare Plant Rank 4.3. Common where it is found but with a limited distribution in the Mojave desert
- Prefers granitic, rocky washes and hillsides
- Stems are 2-15cm tall and can reach up to 30cm in diameter, occur in clumps or solitary
- Spines are short, white, straight, and black tipped
- Flower Color: Pink – dark, to pale, to salmon. Stigmas are white
- Fruit: Spineless
- Recent name change from *Coryphantha alversonii* (Sanchez et al 2022)





Thank you!

Questions?



Cacti of JTNP Field Course
With Desert Institute

Desert Institute Fall 2023

Melanie Davis

melanie.davis@ucr.edu

Illustrated field guides:
Ericameria & Ephedra

