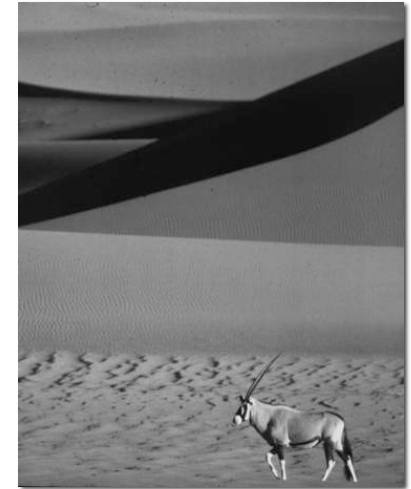


## Deserts

- what are deserts?
- relative term - transitions occur latitudinally with more xeric thorn forests and with grass savannas



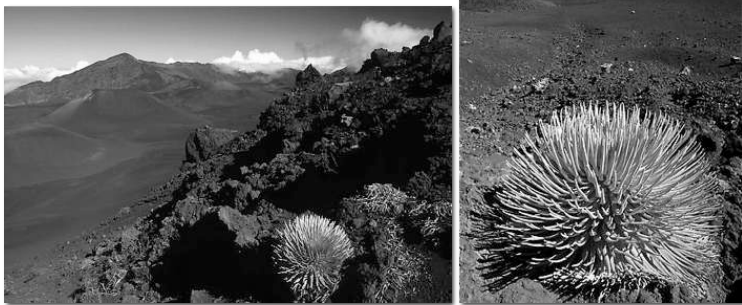
Mojave Desert



Namib Desert

## Deserts

- what are deserts?
- relative term - high elevation tropical mountains (paramo, etc.) are essentially “desert” like



Haleakala Crater - Maui

## Deserts

- what are deserts?
- relative term - high elevation tropical mountains (paramo, etc.) are essentially “desert” like

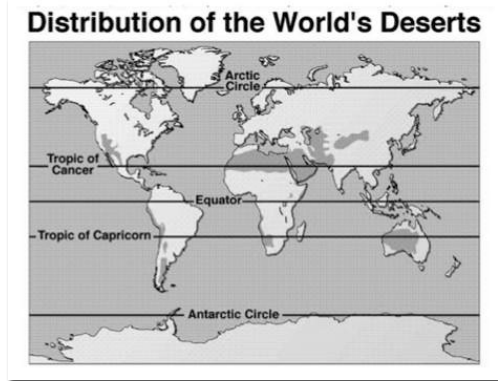


*Opuntia* (Cactaceae) in high Andean puna (Peru)



## Deserts

- what are deserts?
- subtropical arid regions where potential evaporation (>2000mm) is >> annual precipitation (<200mm)

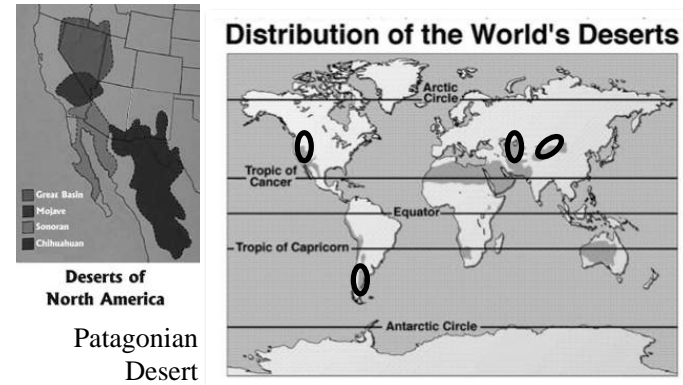


## Deserts

- distinction between subtropical and temperate (cool or cold winter) deserts

Great Basin

Gobi Desert

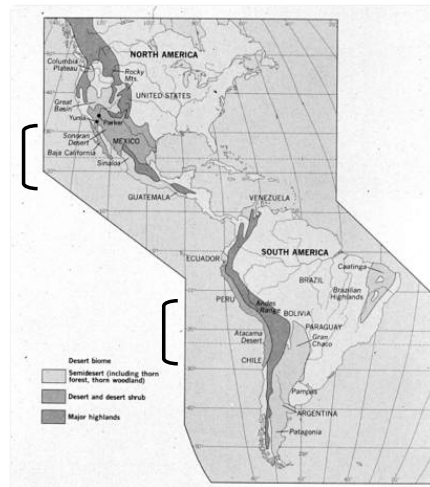


## Desert Locations

- lie between 15° and 30° centered on Tropics of Cancer and Capricorn on west sides of continents

Sonoran,  
Mojave,  
Chihuahuan

Atacama

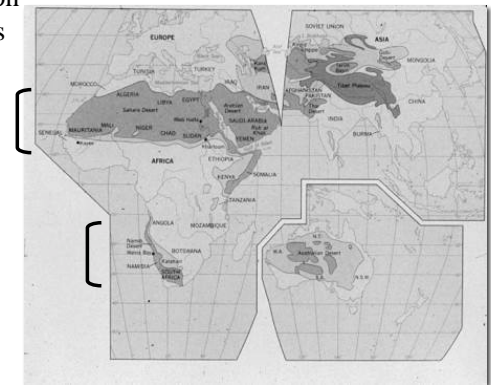


## Desert Locations

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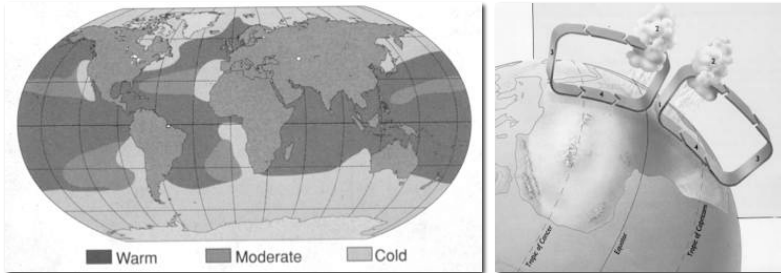
Saharan

Namib,  
Australian



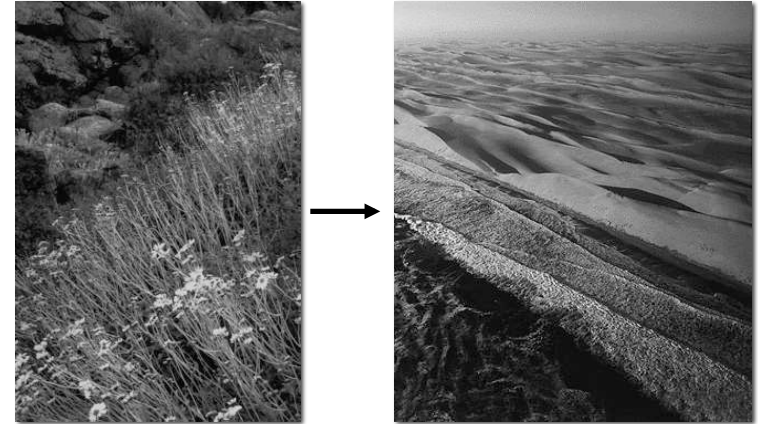
## Desert Climate

- desert climate due to subtropical highs and adiabatic warming of dry air . . .
- . . . and circulation of cold currents (holding little moisture above the currents) along west sides of continents



## Desert Climate

- variation in amount of precipitation from semiarid to rainless deserts



Mojave

Namib (Skeleton coast)

## Desert Climate

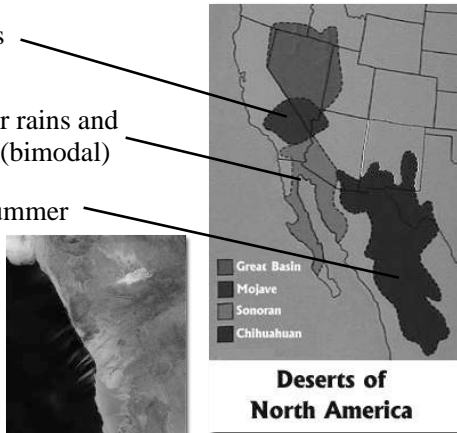
- variation in seasonality of precipitation

Mojave - winter rains (Mediterranean!)

Sonoran - light winter rains and heavier summer rain (bimodal)

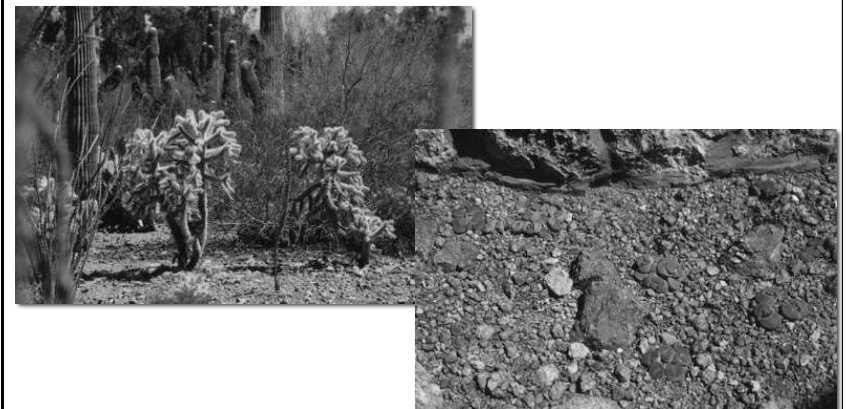
Chihuahuan - only summer rain (subtropical!)

Namib, Atacama - only fog, no rain



## Desert Climate

- soil types: counter-intuitive, but clay soils form driest habitats, sandy soils better water retention, and rocky/fissured soils provide the wettest habitats



## Desert Life Forms

- Halophytes (“salt plants”) - adaptations to salt left behind as water is evaporated at surface of soil



*Salicornia*  
(Chenopodiaceae)

*Tamarix* (Tamaricaceae)

Salt accumulators (often succulent)

Salt excretors



## Desert Life Forms

- Malakophyllus (“soft leaved”) xerophytes (“arid plants”) - adaptations to water stress by wilting under dry conditions



Asteraceae - daisy family

*Sphaeralcea* (Malvaceae) -  
desert globe mallow



## Desert Life Forms

- Succulents - adaptations to water stress by storing water in swollen tissue



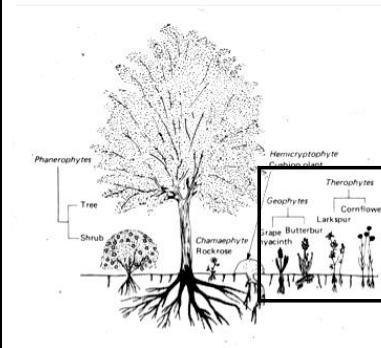
leaves *Aloe* - Africa



stems *Opuntia* - North America

## Desert Life Forms

- Ephemerals - adaptations to water stress by short life



Geophytes (survive under ground)

Therophytes (annuals, survive by seeds)



## Desert Life Forms

- Ephemerals - adaptations to water stress by short life

	Phanero. (trees/ shrubs)	Chamae. (near ground)	Hemicrypto (leaf litter)	Crypto. (under ground)	Thero. (annuals)
Rainforest	96%	2%	0%	2%	0%
Desert	11%	7%	27%	14%	<b>41%</b>
Temperate Deciduous Forest	15%	2%	49%	22%	12%
Tundra	0%	23%	61%	15%	1%

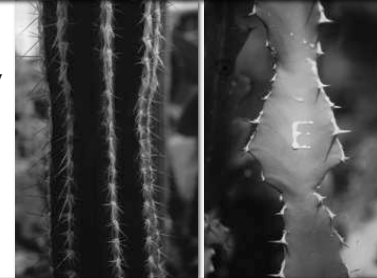
## Desert Life Forms

- Plant defenses - physical and chemical

**Table 4.13** The physical and chemical defences of desert plants against herbivores (after Orians *et al.*, 1977)

Life form	Physical defences	Chemical defences	
		Short-lived tissues	Long-lived tissues
ephemerals	leaves easily chewed; no spines	toxins	
root perennials	leaves easily chewed; no spines	toxins	digestion-reducing substances
deciduous	leaves easily chewed; may have	toxins; digestion-reducing substances	toxins; digestion-reducing substances; low nutrient content
perennials	spines	toxins; digestion-reducing substances	toxins; digestion-reducing substances; low nutrient content
evergreen	leaves tough; usually not	toxins; digestion-reducing substances	toxins; digestion-reducing substances; low nutrient content
perennials	spinescent		toxins; digestion-reducing substances; low nutrient content
succulents	photosynthetic tissue very tough; many spines		toxins; digestion-reducing substances; low nutrient content

Cactaceae - New World spine protected



*Euphorbia* - Old World spine & toxin protected

## Desert Life Forms

- Plant defenses - physical and chemical

**Table 4.13** The physical and chemical defences of desert plants against herbivores (after Orians *et al.*, 1977)

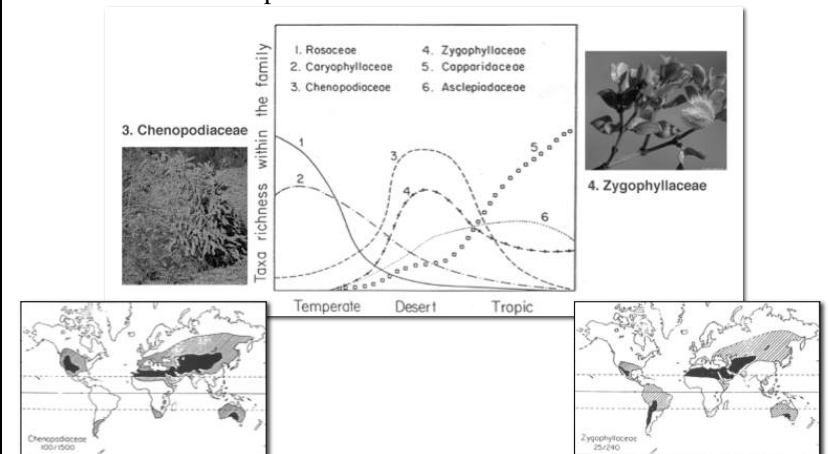
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*Larrea tridentata*  
– Creosote bush



## Desert Floristics

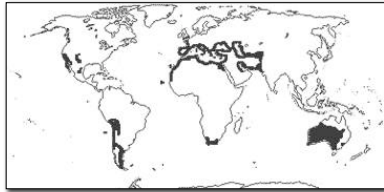
- Three families species richer in deserts than elsewhere



## Desert Floristics

- Three families species richer in deserts than elsewhere

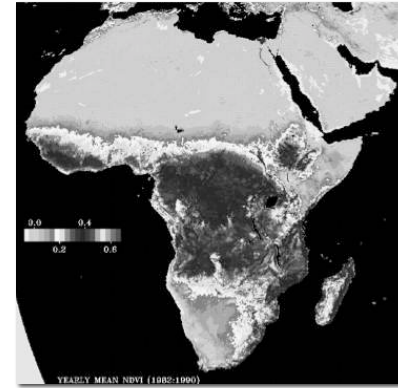
### Frankeniaceae



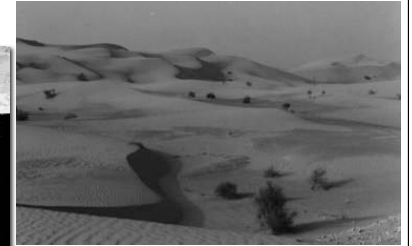
*Frankenia chilensis*

## African Deserts

- Sahara



Yellow indicates lowest photo-synthetically absorbed radiation



## African Deserts

- Sahara

Woody plants: *Phoenix* (date palm) and shrubs (*Acacia*, *Tamarix*, *Ephedra*)

Annuals: Brassicaceae; but also perennial herbs like grasses



*Tamarix* - tamarisk



"mustard" (Brassicaceae) *Phoenix dactylifera* (date palm) - Tunisia



## African Deserts

- Sahara

Stem succulents:  
Apocynaceae (milkweeds)



*Caralluma* & *Sarcostemma*  
(Apocynaceae)  
Ethiopia



Loranthaceae parasitic on *Acacia*  
Ethiopia

Parasites: Loranthaceae

## African Deserts

- Namib - western southern Africa



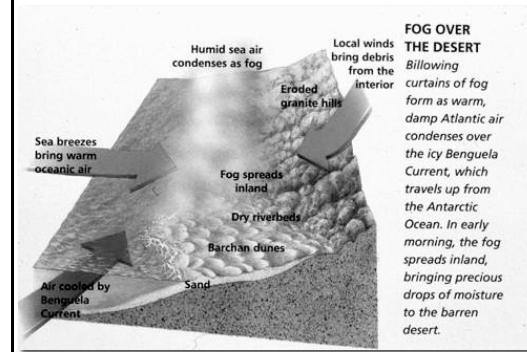
## African Deserts

- Namib - western southern Africa

Fog desert: fog only moisture for most of the year along coast



Darkling beetle - dew specialist



## African Deserts

- Namib - western southern Africa

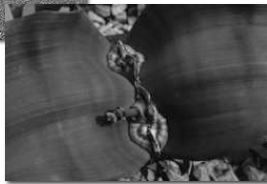
Fog desert: fog only moisture for most of the year along coast



Darkling beetle - dew specialist



*Welwitschia mirabilis*



- nephelophyte - fog specialists



## African Deserts

- Namib - western southern Africa



*Eriospermum paradoxum*

- nephelophyte - fog specialists of Namaqualand - the "curlie-whirlies"



*Trachyandra*

## African Deserts



- nephelophyte - fog specialists of Namaqualand -the "curly-whirlies"

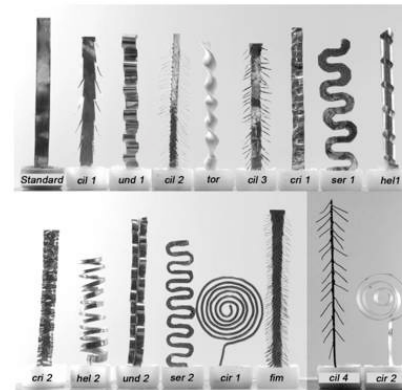
*Trachyandra*

## African Deserts

Desert geophytes under dew and fog: The "curly-whirlies" of Namaqualand (South Africa)

Stefan Vogel<sup>1,2</sup>, Ute Müller-Dobies<sup>3,1</sup>

<sup>1</sup>Institut für Biologie der Universität Wien, Rennweg 14, A-1080 Wien, Österreich, Austria  
<sup>2</sup>Lehrstuhl für Biologie der Universität Bonn, Sigmund-Freud-Straße 25, D-53115 Bonn, Deutschland, Germany  
<sup>3</sup>Lehrstuhl für Biologie der Universität Bonn, Sigmund-Freud-Straße 25, D-53115 Bonn, Deutschland, Germany



*Trachyandra*

## African Deserts

- Namib - western southern Africa

Stem succulents: *Aloe* (Liliaceae s.l.), *Euphorbia*, *Pachypodium* (Apocynaceae)



*Aloe* - quiver plant

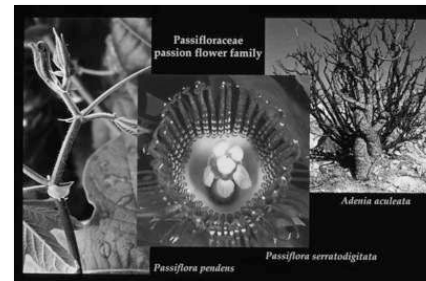


*Pachypodium*

## African Deserts

- Namib - western southern Africa

Stem succulents: *Stapelia* (Apocynaceae) - cactus mimic; *Adenia* (Passifloraceae)



*Stapelia* - carrion flower

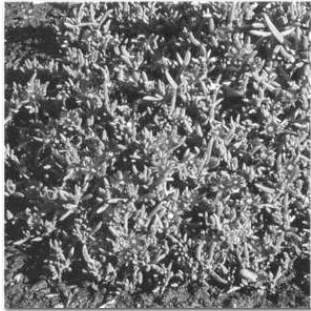
*Adenia*



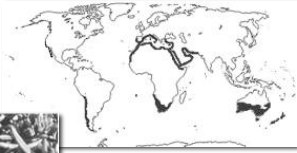
## African Deserts

- Namib - western southern Africa

Leaf succulents:  
Aizoaceae - cactus  
mimics



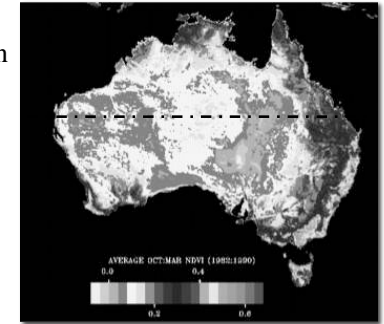
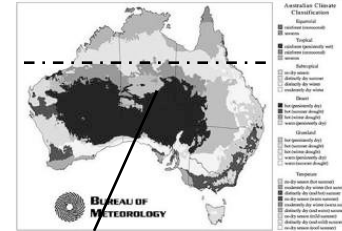
*Delosperum*



*Lithops* - living stones

## Australian Deserts

- One quarter of Australia is “desert” - largest is the Simpson desert



Deserts straddle  
Tropic of Capricorn



## Australian Deserts

- Spinifex desert type: desert grassland dominated by *Triodia* grass hummocks



## Australian Deserts

- Spinifex desert type: desert grassland dominated by *Triodia* grass hummocks

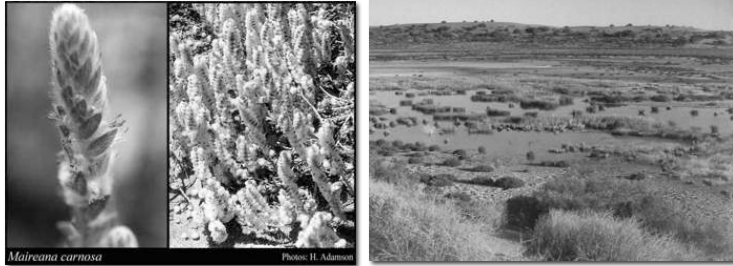


*Casuarina* - desert oak - N<sub>2</sub> fixing!

Grass trees, Xanthorrhoeaceae (endemic to Australia, 9 genera, 75 spp.)

## Australian Deserts

- Saline desert type: low vegetation dominated by salt-tolerant bluebush, saltbush, and other Chenopodiaceae



*Maireana* (Amaranthaceae) - bluebush

Williams Creek - saline

## Australian Deserts

- Mulga desert type: perhaps transitional with extreme arid woodlands but covers 20% of Australia - dominated by *Acacia aneura* (mulga)

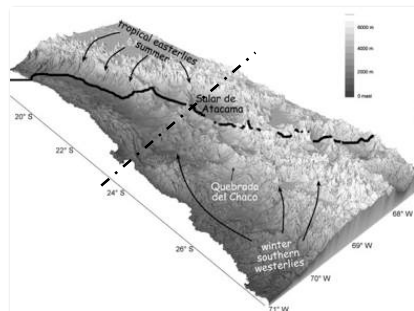


*Acacia aneura* - mulga



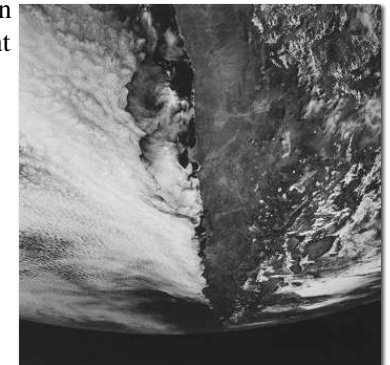
## South American Deserts

- Atacama - w Chile & SW Peru - straddles Tropic of Capricorn on Pacific Ocean edge of S America
- essentially a rainless desert in the shadow of the Andes



## South American Deserts

- Atacama - w Chile & SW Peru - straddles Tropic of Capricorn on Pacific Ocean edge of S America
- a fog desert: note moisture laden clouds over cold Humboldt current stop at edge of continent



## South American Deserts

- Atacama - w Chile & SW Peru - straddles Tropic of Capricorn on Pacific Ocean edge of SAmerica
- a fog desert: note moisture laden clouds over cold Humboldt current stop at edge of continent
- orographic precipitation is always inland at higher elevations due to adiabatic effect

Coastal cloud wall  
in Pan de Azucar



## South American Deserts

- Atacama - western Chile & southwestern Peru - straddles Tropic of Capricorn on Pacific Ocean edge of South America
- rainless desert with plants (nephelophytes) adapted to capture fog moisture as lomas (small hill) vegetation

*Tillandsia landbeckii*  
(Bromeliaceae) - same  
genus as Spanish moss



## South American Deserts

*Eulychnia iquiquensis* (Cactaceae),  
*Copiapoa* (Cactaceae) & *Euphorbia*  
*latifolia* (Euphorbiaceae)



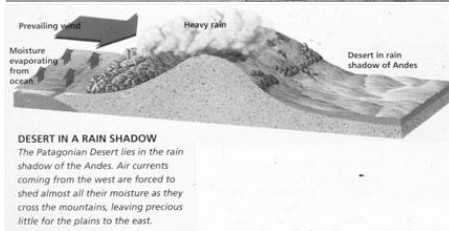
## South American Deserts

*Malesherbia tocopillana*  
(Malesherbiaceae) - family of 1  
genus and 24 species restricted to  
west coast of South America



## South American Deserts

- Patagonian - temperate desert formed by rainshadow of Andes



## North American Deserts

- 4 recognized: variation in seasonality of precipitation

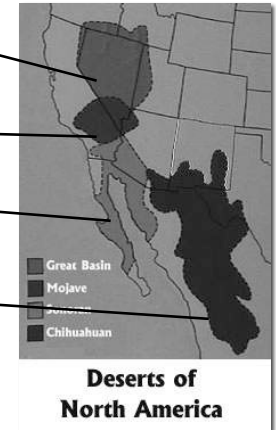
Great Basin - cold winter desert (temperate, montane rain shadow)

Mojave - winter rains (Mediterranean!)

Sonoran - light winter rains and heavier summer rain (bimodal)

Chihuahuan - only summer rain (subtropical!)

- floristically related & intergrade



## North American Deserts

- Chihuahuan - subtropical



## North American Deserts

- Chihuahuan



*Larrea tridentata* (Zygophyllaceae)  
creosote bush - also in South America



## North American Deserts

- Chihuahuan

*Acacia constricta* - white thorn acacia



*Flourensia cernua* (Asteraceae) tarbush



## North American Deserts

- Chihuahuan



*Ariocarpus* (Cactaceae) - Big Bend National Park, Texas



Gran Desierto del Pinacate National Park, Mexico - sand verbena (*Verbena*) & creosote

## North American Deserts

- Sonoran - subtropical/Mediterranean - divided into floristic/ climatic subgroups



*Carnegiea gigantea* (Cactaceae) - saguaro "Queen of the Sonoran"

## North American Deserts

- Sonoran



*Cereus thurberi* - organpipe



*Opuntia bigelovii* - cholla

## North American Deserts

### ▪ Sonoran



*Cercidium microphyllum* (Fabaceae) - palo verde

## North American Deserts

### ▪ Sonoran



*Prosopis glandulosa* (Fabaceae) - mesquite (pinole)

## North American Deserts

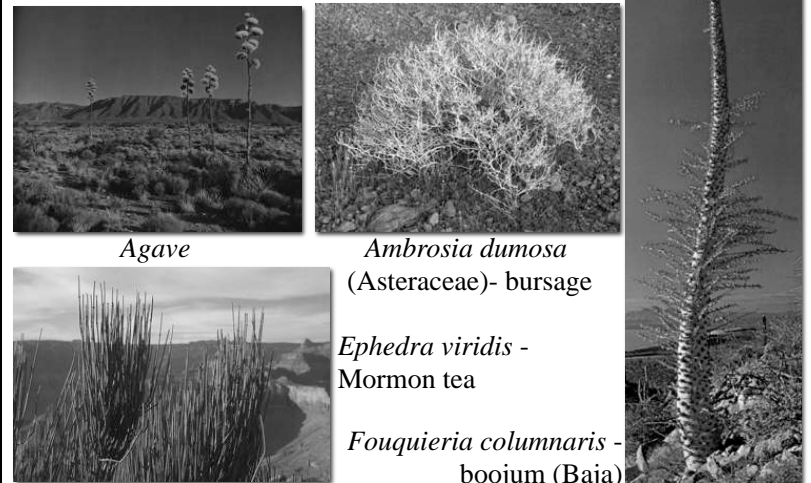
### ▪ Sonoran



*Fouquieria splendens*  
(Fouquieriaceae) - ocotillo

## North American Deserts

### ▪ Sonoran



*Agave*

*Ambrosia dumosa*  
(Asteraceae)- bursage

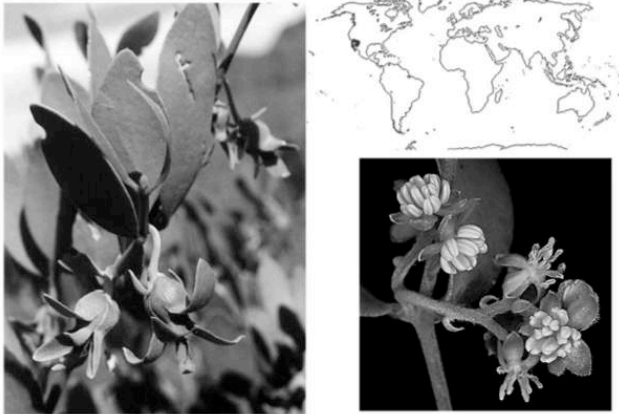
*Ephedra viridis* -  
Mormon tea

*Fouquieria columnaris* -  
boojum (Baja)

## North American Deserts

- Sonoran

*Simmondsia chinensis* — Simmondsiaceae  
Sonoran Desert endemic



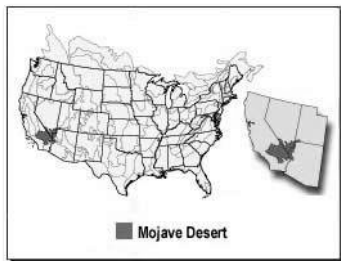
## North American Deserts

- Sonoran - two rainy seasons produces diverse annual species



## North American Deserts

- Mojave - Mediterranean (winter rain) cooler desert



Elements from the Californian Mediterranean flora are seen, but a good number of endemic species

## North American Deserts

- Mojave



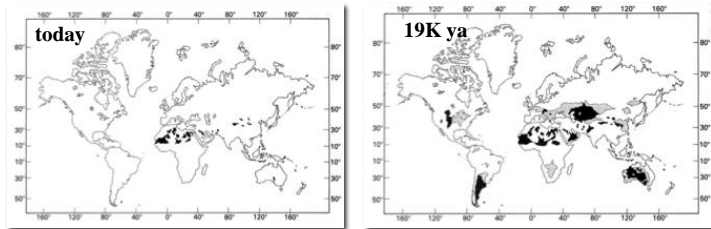
*Yucca* sp.

*Yucca brevifolia*, Joshua  
Tree National Park



## Issues in Biogeography of Deserts

- Evolution of Desert Floras
  1. Geological evidence arid times since Devonian (400mya)
  2. Axelrod (1958) - desert flora originated in Miocene (24mya) and Pliocene (2.5mya)
  3. Schmida (1985) and Whittaker (1977): distinctive life forms and species diversity in desert indicate even more ancient



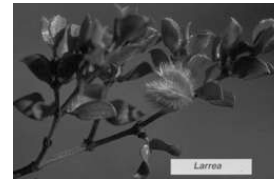
Distribution of sand deserts

## Issues in Biogeography of Deserts

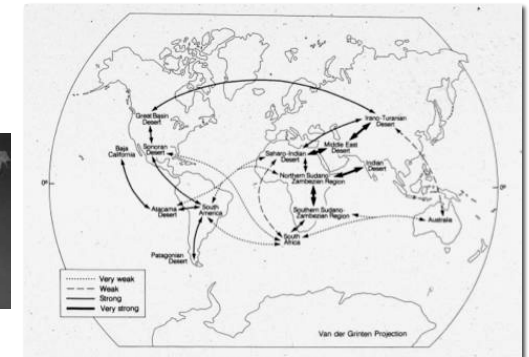
- Floristic Relationships

Strong links within floristic areas

Weak links between floristic areas except N-S movement



Creosote bush in North and South America



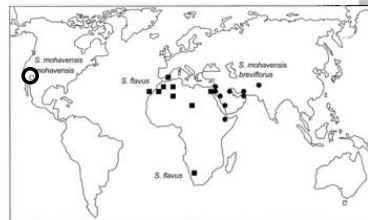
## Issues in Biogeography of Deserts

- Floristic Relationships

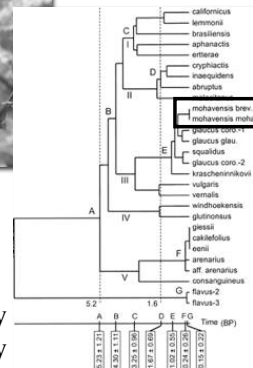
DNA evidence for very recent long distance dispersal of *Senecio mohavensis* across Atlantic



*Senecio mohavensis* subsp. *mohavensis*



DNA family history



## Issues in Biogeography of Deserts

- Invasives

Tamarisk invasive in Chihuahuan Desert (Big Bend National Park) - native to African deserts

