Deserts
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

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

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

Salt accumulators (often succulent)

Salt excretors

*Salicornia* (Chenopodiaceae)

*Tamarix* (Tamaricaceae)
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

<table>
<thead>
<tr>
<th></th>
<th>Phanero. (trees/shrubs)</th>
<th>Chamae. (near ground)</th>
<th>Hemicrypto (leaf litter)</th>
<th>Crypto. (under ground)</th>
<th>Thero. (annuals)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rainforest</strong></td>
<td>96%</td>
<td>2%</td>
<td>0%</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Desert</strong></td>
<td>11%</td>
<td>7%</td>
<td>27%</td>
<td>14%</td>
<td><strong>41%</strong></td>
</tr>
<tr>
<td><strong>Temperate Deciduous Forest</strong></td>
<td>15%</td>
<td>2%</td>
<td>49%</td>
<td>22%</td>
<td>12%</td>
</tr>
<tr>
<td><strong>Tundra</strong></td>
<td>0%</td>
<td>23%</td>
<td>61%</td>
<td>15%</td>
<td>1%</td>
</tr>
</tbody>
</table>
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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<tr>
<th>Life form</th>
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<th>Chemical defences</th>
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<td>toxins</td>
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<tr>
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<td>toxins; digestion-reducing substances</td>
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<td>leaves tough; usually not spinescent</td>
<td>toxins; digestion-reducing substances</td>
</tr>
<tr>
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<td>photosynthetic tissue very tough; many spines</td>
<td>digestion-reducing substances; low nutrient content</td>
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<td></td>
<td></td>
<td>Long-lived tissues</td>
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<td></td>
<td>toxins; digestion-reducing substances; low nutrient content</td>
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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 Florisitics

- Three families species richer in deserts than elsewhere
Desert Florisitics

- Three families species richer in deserts than elsewhere

Frankeniaceae

*Frankenia chilensis*
African Deserts

- Sahara

Yellow indicates lowest photosynthetically absorbed radiation
African Deserts

- Sahara

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

**Annuals:** Brassicaceae; but also perennial herbs like grasses

“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

![Image of a Darkling beetle - dew specialist](image)

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**FOG OVER THE DESERT**

Billowing curtains of fog form as warm, damp Atlantic air condenses over the icy Benguela Current, which travels up from the Antarctic Ocean. In early morning, the fog spreads inland, bringing precious drops of moisture to the barren desert.
African Deserts

- Namib - western southern Africa

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

- *Welwitschia mirabilis*
  - nephelophyte - fog specialists

- Darkling beetle - dew specialist
African Deserts

- Namib - western southern Africa

*Errospermum paradoxum*

- nephelophyte - fog specialists of Namaqualand - the “curlie-whirlies”

*Trachyandra*
African Deserts

- **nephelophyte** - fog specialists of Namaqualand - the “curlie-whirlies”

*Trachyandra*
African Deserts

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

Stefan Vogel¹, 2, Ute Müller-Doblieb ³

¹ Institut für Botanik der Universität Wien, A-1090 Vienna, Austria
² Institut für Biologie, Systematische Botanik und Pflanzengeographie der Freien Universität Berlin, D-14195 Berlin, Deutschland, Germany
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

*Delospermum*

*Lithops* - living stones
Australian Deserts

- One quarter of Australia is “desert” - largest is the Simpson desert.
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 - N2 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 SAmerica
- 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 SAmerica

- 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

*Yucca*
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* - chollo
North American Deserts

- Sonoran

*Cercidium microphyllum* (Fabaceae) - palo verde
North American Deserts

- Sonoran

*Prospis glandulosa* (Fabaceae) - mesquite (pinole)
North American Deserts

- Sonoran

*Fouquieria splendens* (Fouquieriaceae) - ocotillo
Sonoran

Agave

Ambrosia dumosa (Asteraceae)- bursage

Ephedra viridis - Mormon tea

Fouquieria columnaris - boojum (Baja)

North American Deserts
North American Deserts

- Sonoran

*Simmondsia chinensis* — *Simmondsiaceae*
Sonoran Desert endemic

![Image of Sonoran Desert plant](image-url)
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 brevifolia*, Joshua Tree National Park

*Yucca sp.*
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

19K ya

today
Issues in Biogeography of Deserts

- **Floristic Relationships**

  Strong links within floristic areas
  
  Weak links between floristic areas except N-S movement

[Image of 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