

# Tundra and Alpine



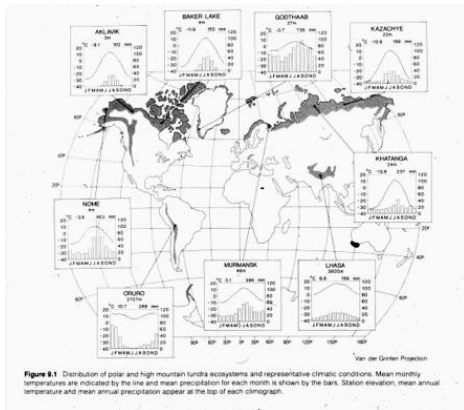
## Tundra Biomes

- Tundras are characteristic of Arctic or Alpine regions where the severity of environmental conditions excludes tree growth. 30 days of 10°C ave. temperature and 8 mos cold season.



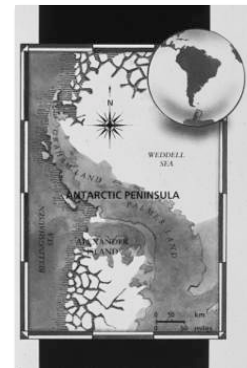
## Tundra Biomes

- Arctic tundra occurs north of the boreal forest or taiga and thus form a treeless ring south of the zone of permanent ice (North America, Greenland, Eurasia).

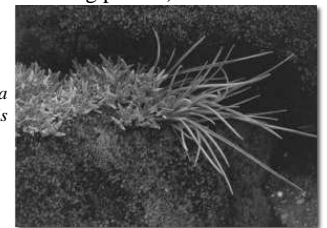


## Tundra Biomes

- In the Antarctica, tundra area is very small because of the lack of large continental masses. Develops only on certain small Antarctic islands such as South George and MacQuarie Island on several spots on the most northerly extension of Antarctica proper (only 2 flowering plants!)



*Deschampsia antarctica*  
*Colobanthus quitensis*



Only 2 angiosperms - Antarctic hairgrass, pearlwort - on north facing slopes with moss and liverworts

Antarctic Peninsula - 600 mi or 1000 km from South America

## Tundra Biomes

- In the wet subAntarctic, tussocks and megaherbs are characteristic



Tussock *Poa litorosa* in subantarctic Campbell Island



Megaherb *Pleurophyllum speciosum* in subantarctic Campbell Island

## Tundra Biomes

- Alpine regions include Rocky Mountains, European Alps, Himalayas, and Austral-antarctic area (South Island, also Tasmania, Snowy Mts. in Australia).



Alpine summit, Bighorn Natl Forest, 9000ft, Wyoming with *Ranunculus adoneus* (snow buttercup)



Alpine tundra, Summit Lake, SW Idaho Springs, CO - *Rydbergia grandiflora*, *Polygonum bistortoides* (American bistort)

## Tundra Biomes

- Exclude tropical 'puna' in Andes and similar high elevation peaks in East Africa (will deal with later). Links of Austral-antarctic region with puna (*Azorella*, Umbelliferae).



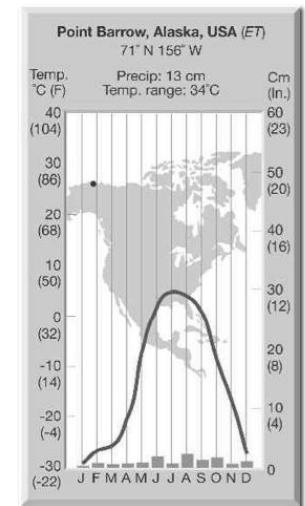
Peru - puna, 4300 ft



*Azorella* (Apiaceae)

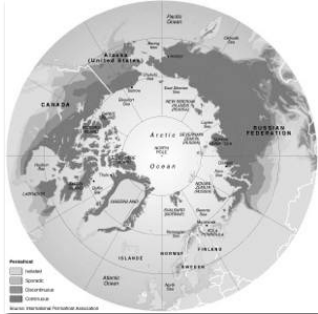
## Tundra Biomes

- Low precipitation; less than 400 mm per year, usually only up to 150 mm — less rain than most subtropical deserts!
- Subzero temperatures most of the year. A short vegetative period of generally less than 50 days between spring and autumn frost.



## Tundra Biomes

- Permanently frozen sub-soil. Permafrost of variable depth.
- Consequences are physical barrier to roots, low temperatures suppress decomposition and promotes peat, and retard water percolation and promotes swampy or boggy conditions



Locations of permafrost in tundra and high boreal



## Tundra Biomes

- Life forms: chamaephytes (incl. subshrubs) and hemicryptophytes by far the dominant forms, often cushions

Tasmanian (Mt. Anne), montane cushions, largest in the world, *Abrotanella*, Asteraceae, 12 ft across with  $10^6$  stems

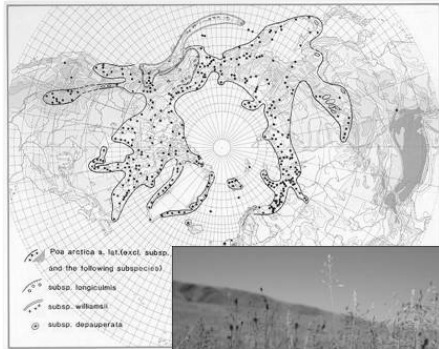


Moss campion (*Silene acaulis*) and purple saxifrage (*Saxifraga oppositifolia*) at Svalbard



## Tundra Biomes

- Life forms: grasses and sedges dominate (e.g., North America: *Poa arctica*, alpine meadow grass; *Carex bigelowii*, rigid sedge)



*Poa arctica* - alpine meadow grass



*Carex bigelowii* - arctic sedge

## Tundra Biomes

- Life forms: vegetative reproduction common (bulbils or vivipary; eg. *Polygonum viviparum*, alpine bistort)



*Polygonum viviparum* - alpine bistort



*Poa alpina* var. *vivipara*



## Tundra Biomes

- Life forms: apomixis, wind and “generalized” fly/bee pollinated - incidence of conspicuously-open bowl flowers increases towards the arctic



St. Paul Island, Alaska tundra



*Ranunculus* - buttercup

## Tundra Biomes

- Life forms: apomixis, wind and “generalized” fly/bee pollinated - incidence of conspicuously-open bowl flowers increases towards the arctic



*Cerastium* - chickweed



*Saxifraga* - saxifrage



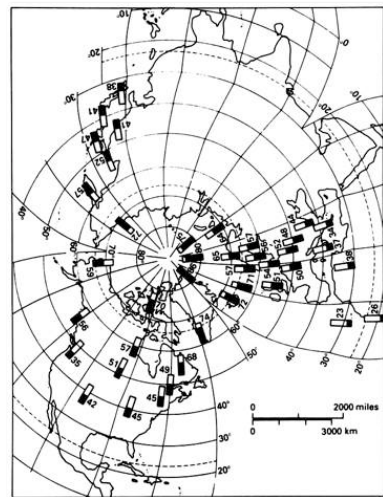
*Papaver* - poppy

## Tundra Biomes

- Life forms: Polyploidy



Frequency of **polyploids** (black %) in the floras of various territories in the Northern Hemisphere (from Love and Love, 1974)



## Tundra Biomes

- Life forms: Polyploidy

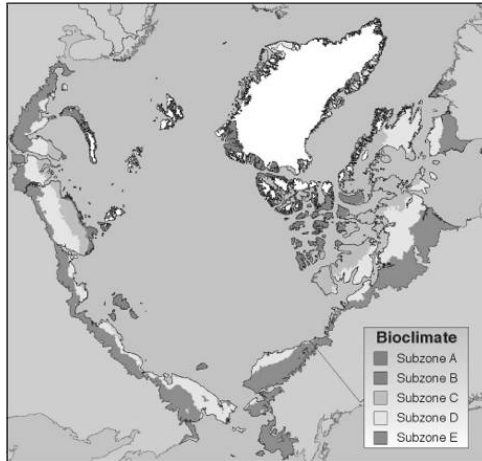


Spitsbergen

**Table 24.1.** Frequency of polyploid species of angiosperms in different latitudinal zones in Eurasia and the Arctic. (condensed from Löve and Löve 1957; and Hanelt 1966)

Area	Latitude N°	Polyploids, %
Sicily	36–38	37.0
Rumania	44–47	46.8
Hungary	46–49	48.6
Pardubice, CSR	50	52.3
Central Europe	46–55	50.7
Schleswig-Holstein	54–55	54.5
Denmark	54–58	53.5
England	50–61	52.8
SW Greenland	60–62	74.0
Faroes	62	71.0
Iceland	63–66	71.2
Sweden	55–69	56.9
Finland	60–70	57.3
Norway	58–71	57.6
NW Alaska	68	59.3
Devon Island	75	76.0
Spitsbergen	77–81	74.0
Franz Joseph Land	80–82	75.0
Peary Land	82–84	85.9

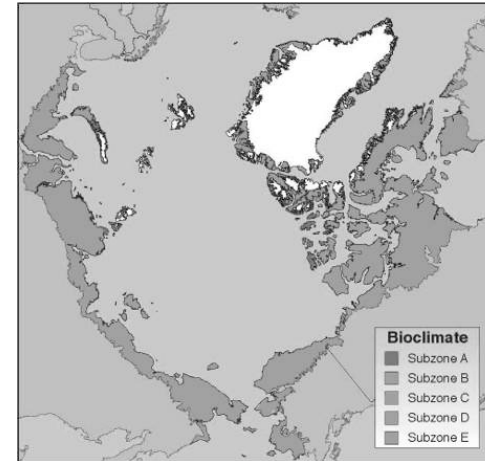
## Tundra Biomes



<http://www.arcticatlas.org/atlas/cavm/cavmbz/index.shtml>

- **High arctic** - herbs
- **Middle arctic** - dwarf shrub
- **Low arctic** - shrubby heath, small trees

## Tundra SubBiomes



**Herb subzone**

Mean July temperature: 0-3 °C  
Summer warmth index <6 °C

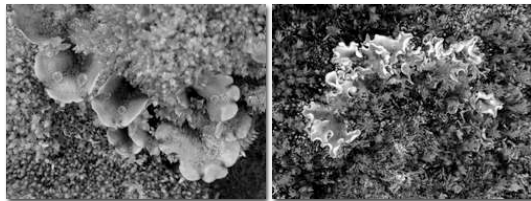
Fog-shrouded islands near arctic icepack

Dominated by herbs - the "high arctic"



*Papaver* - poppy

## Tundra SubBiomes



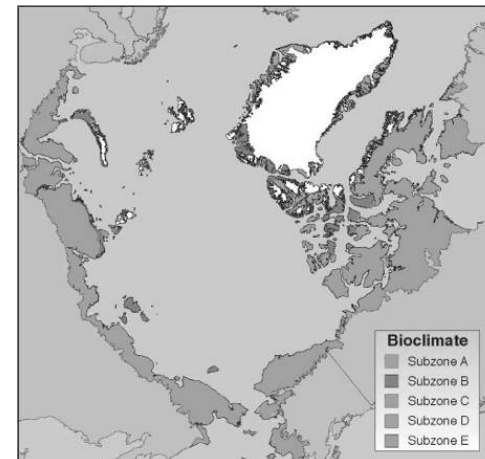
Dominant plant growth forms:  
Cushion forbs, mosses, lichens

Number of vascular plant  
species in local flora <50



**Herb subzone**

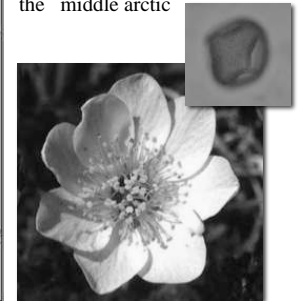
## Tundra SubBiomes



**Prostrate shrub (or *Dryas*)  
subzone**

Mean July temperature: 3-5 °C  
Summer warmth index: 6-9 °C

Transitional to subzone C and  
together they have been called  
the "middle arctic"



*Dryas* - mountain avens  
(Rosaceae) & pollen

## Tundra SubBiomes



*Dryas octopetala*



*Salix herbacea* - least willow



*Salix polaris* - polar willow



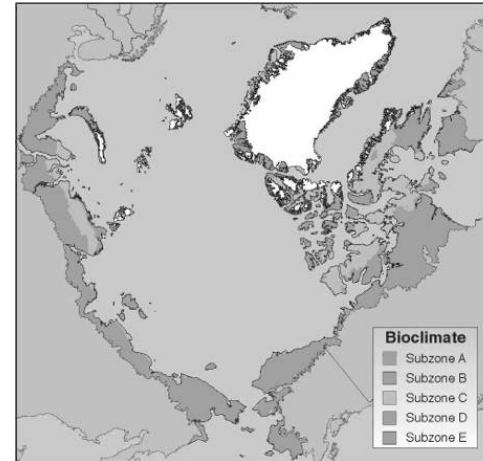
*Cerastium regellii* - chickweed

Dominant plant growth form:  
Prostrate dwarf shrubs

Number of vascular plant  
species in local flora: 50-100

**Prostrate shrub (or *Dryas*)  
subzone**

## Tundra SubBiomes



**hemi-prostrate dwarf-shrub  
(or *Cassiope*) subzone**

Mean July temperature: 5-7 °C  
Summer warmth index: 9-12 °C



*Cassiope tetragona*  
(Ericaceae) - Arctic bell  
heather

## Tundra SubBiomes



*Carex bigelowii* -  
arctic sedge



*Juncus trifidus* - rush

Dominant plant growth forms:  
Hemi-prostrate dwarf shrubs,  
sedges

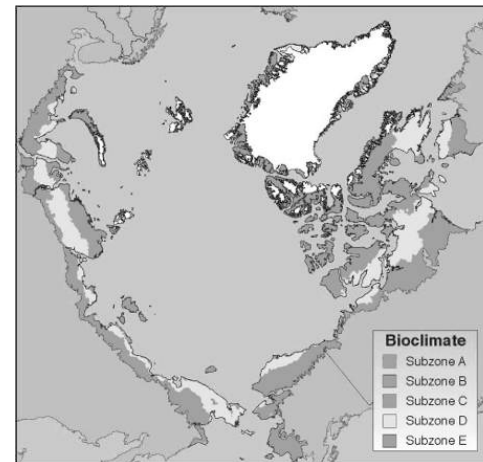
Number of vascular plant  
species in local flora: 75-150



*Cassiope tetragona*  
(Ericaceae) - Arctic bell  
heather

**hemi-prostrate dwarf-shrub  
(or *Cassiope*) subzone**

## Tundra SubBiomes



**Erect-shrub (or *Betula nana*)  
subzone**

Mean July temperature: 7-9 °C  
Summer warmth index: 12-20 °C

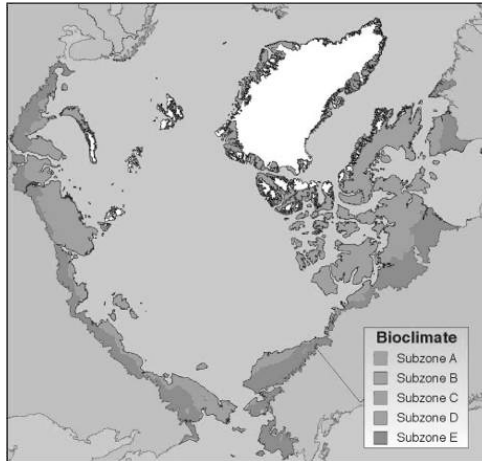
Dominant plant growth forms:  
Erect dwarf shrubs, sedges,  
mosses

Number of vascular plant  
species in local flora: 125-250





## Tundra SubBiomes



Low shrub (or *Alnus*) subzone

Mean July temperature: 9-12 °C  
Summer warmth index: 20-35 °C  
Dominant plant growth forms:  
Low shrubs, tussock sedges,  
mosses  
Number of vascular plant  
species in local flora: 200-500



## Tundra Biomes

- Floristics: Circum-boreal distribution common, Amphi-atlantic, Amphi-pacific often the case as well



*Rhododendron lapponicum* in Wisconsin



Figure 4.7 The range of *Rhododendron lapponicum* (Lapland rosebay) showing its bi-centric distribution in Scandinavia. (Adapted from Guericke, 1963.)

in Scandinavia

## Tundra Biomes

- Floristics: Circum-boreal distribution common, Amphi-atlantic, Amphi-pacific often the case as well — sometimes as different varieties



*Vaccinium vitis-idaea* var. *minus*  
(mountain cranberry in North  
America)

*Vaccinium vitis-idaea* var. *vitis-idaea* (lingon in Eurasia)



## Tundra Biomes

- Faunistics: Circum-boreal distribution common as with caribou (North America) and reindeer (Eurasia) — slightly different looking but same species *Rangifer tarandus* (actually a number of subspecies)



## Tundra Biomes

- Faunistics: other Circum-boreal distributions



Arctic squirrel



Arctic fox

Arctic hare



Muskox



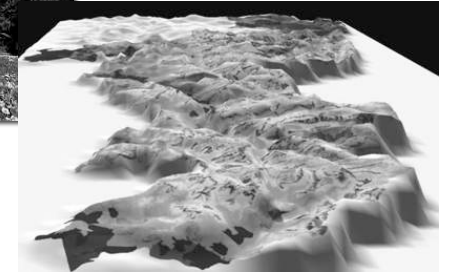
## Alpine Biomes

- Floristics: Alpine vegetation does not form continuous expanses but are best characterized as islands



Eagles Nest Wilderness, Colorado

Alpine meadow distribution -  
European alps



## Alpine Biomes

- Floristics: Alpine vegetation shows very close resemblances both in life-forms and in species composition to that of the Arctic tundra. A whole group of species are common to both and referred to as 'Arctic-Alpine' species.



*Salix arctica* - Alpine willow



*Cerastium* - chickweed, Colorado Rocky Mts.

## Alpine Biomes

- Floristics: Important Alpine families - Gentianaceae (gentians), Primulaceae (primroses)



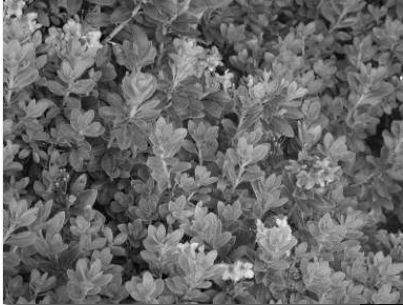
*Primula farinosa* & *Gentiana verna*, Austrian alps





## Alpine Biomes

- Floristics: Important Alpine families - Ericaceae (blueberries), Rosaceae (avens)



*Rhododendrum hirsutum* in Alps



*Dryas*, Switzerland Alps

## Alpine Biomes

- Floristics: Important Alpine families - Portulacaceae (spring beauty, bitterroot)



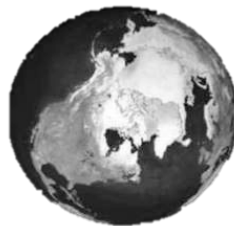
*Claytonia megarhiza* - alpine spring beauty - western North America



*Lewisia rediviva* - bitterroot - Montana

## Tundra Biomes

- Origins
- forest grew at high latitudes across North America and Eurasia until the late Pliocene (3mya)
- fossil remains of dawn redwood, swamp cypress, *Ginkgo*, and other broad-leaved genera are common throughout the Canadian Arctic and Eastern Siberia
- Alaska (most of it) switched over from coniferous forest to shrubby and herbaceous tundra during the Pleistocene epoch (2mya)
- bipolar distributions occur because of high elevation zones in mountain ranges running through North and South America
- the alpine flora in southern Hemisphere appear to be relictual from an extensive tundra flora in Antarctica prior to being covered by ice



## Tundra Biomes

- Future? environment360 report
- most impacted biome by warming temperatures
- +3-5° F in last 50 years; up to 10° F above pre-industrial levels by 2100
- shift from “herbaceous” to shrub tundra (“tundra” means “treeless plain” in Finnish)
- increased incidence of fire, slumping hillsides
- 2X as much C exists in permafrost as in atmosphere . . .
- . . . and large amounts of methane – even more potent greenhouse gas

