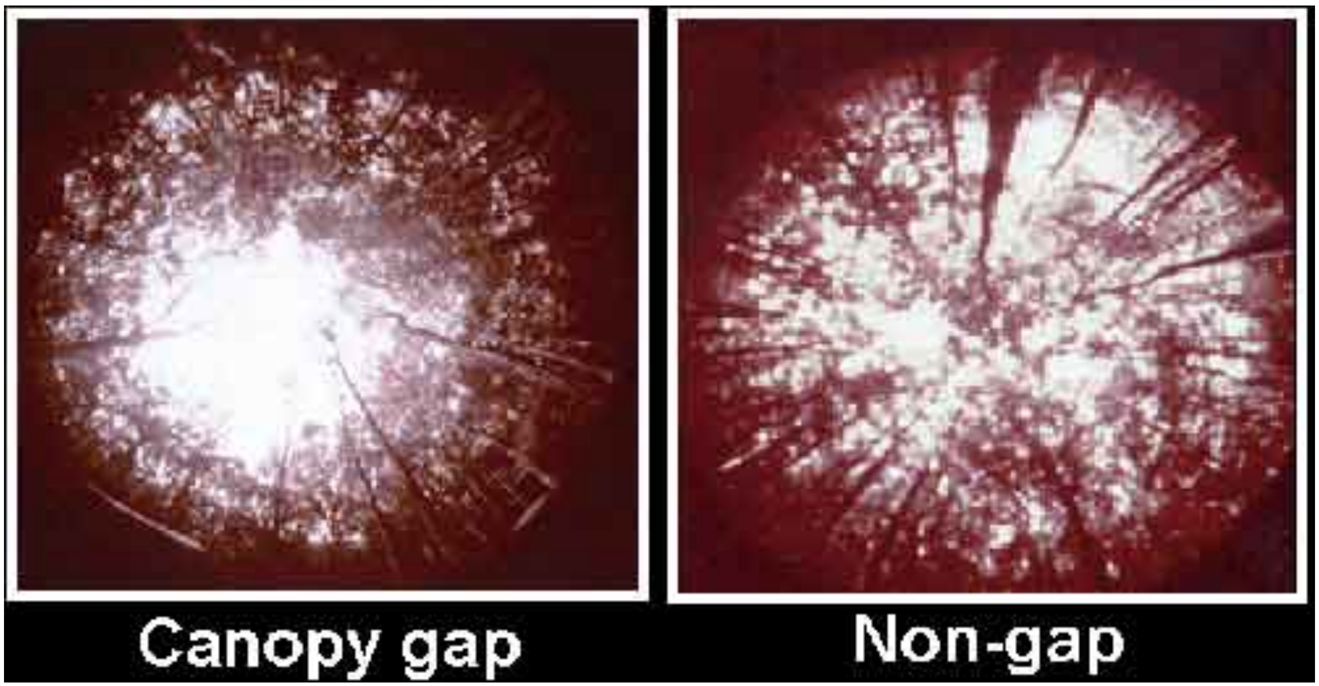
Physical environment

How does canopy cover affect light penetration?

PAR = 185 µmol/m2/s **PAR = 67 µmol/m2/s**



www.uga.edu/srel/ESSite/MMLight_acclimation.htm

Physical environment

Canopy: 90% of photosynthesis

Understory: 10% of photosynthesis on only 1% of light available at top of the canopy

library.thinkquest.org/26252/explore/3.htm Images: Steven Holt

Physical environment

Adaptations to light

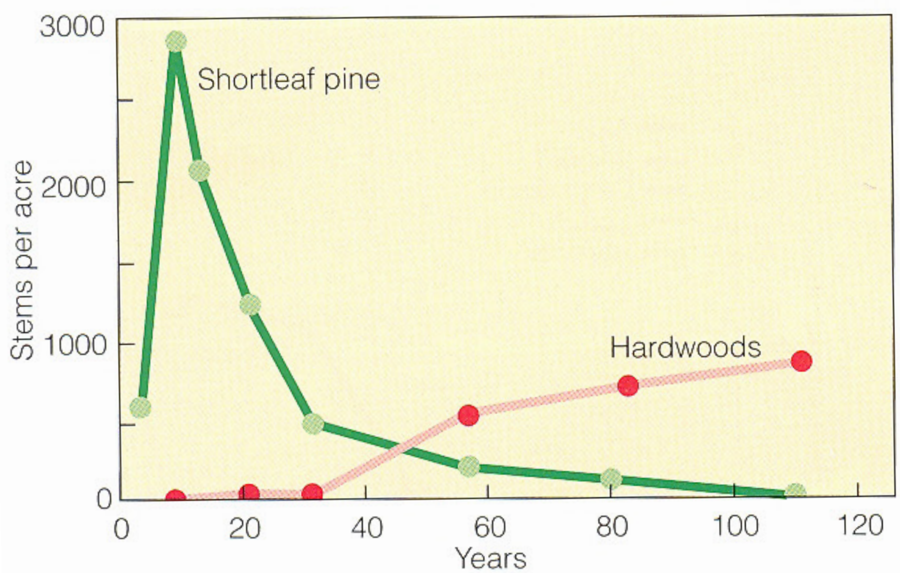


Figure 18.6 | Decline in the abundance of shortleaf pine (*Pinus echinata*) and increase in the density of hardwood species (oak, *Quercus*, and hickory, *Carya*, species) during secondary succession on abandoned farmland in the Piedmont region of North Carolina. (Adapted from Billings 1938.)

Figure 18.7 | A kelp forest off the Aleutian Islands of Alaska: *Cymathera triplicata* (foreground); *Alaria fistulosa* (rear). Kelp forests in the eastern and northern Pacific commonly have complex three-dimensional structure, with many coexisting species. As in coral reefs, shading is a major mechanism of intraspecific and interspecific competition.

Smith and Smith, 2006

Physical environment

UV Radiation Controls on Species Distributions

Escape of zooplankton in water column from UV radiation

Concentration higher in water column without UVB

Concentration lower in water column with UVB

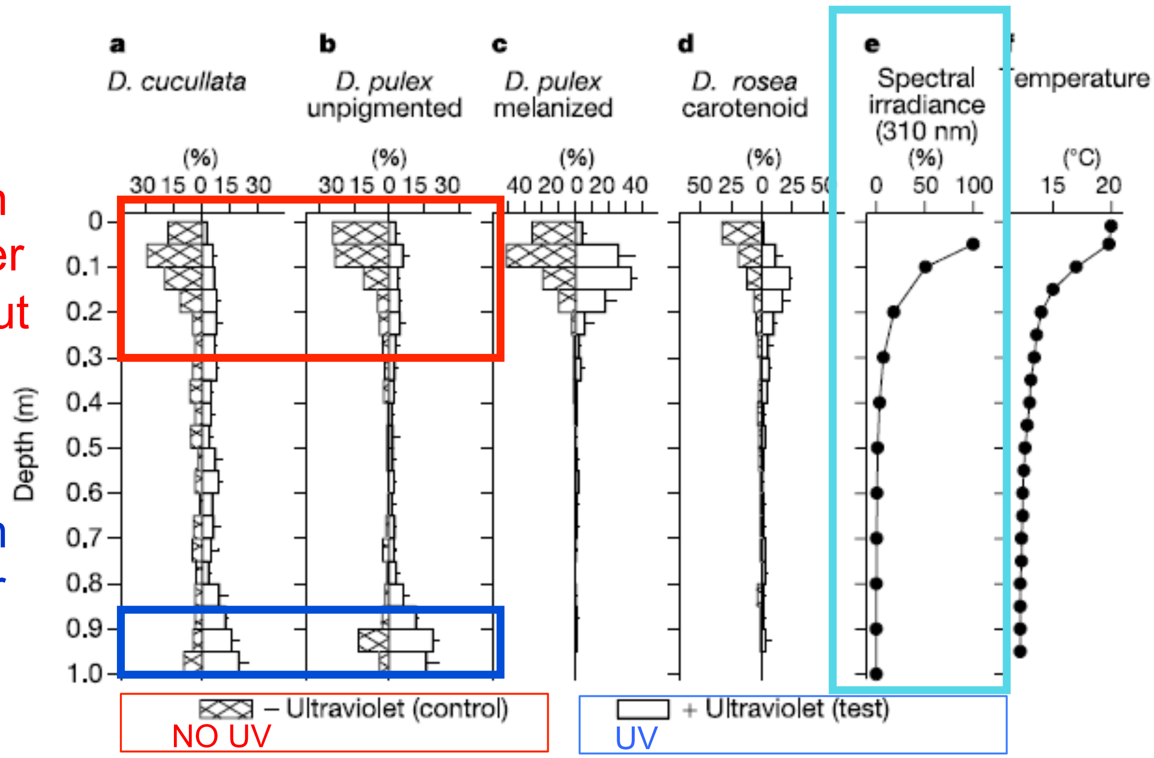


Figure 2 Results from laboratory experiments. **a**–**d**, Vertical distribution of unpigmented *D. cucullata* (**a**) and *D. pulex* (**b**); melanized *D. pulex* (**c**); and *D. rosea* with carotenoids (**d**), in mesocosms (height 1 m; diameter 46 mm). **e**, **f**, We measured the vertical gradient of radiation (**e**) and the vertical temperature gradient (**f**). Data represent means of three replicates (± 1 s.d.) taken as the mean of five repeated measurements. Measured values of depth distribution in all experiments showed a significantly deeper position of daphnids in ultraviolet treatments (Mann–Whitney *U*-test; $P < 0.0001$).

Rhode et al., 2001

Physical environment

Species variability in temperature optimum

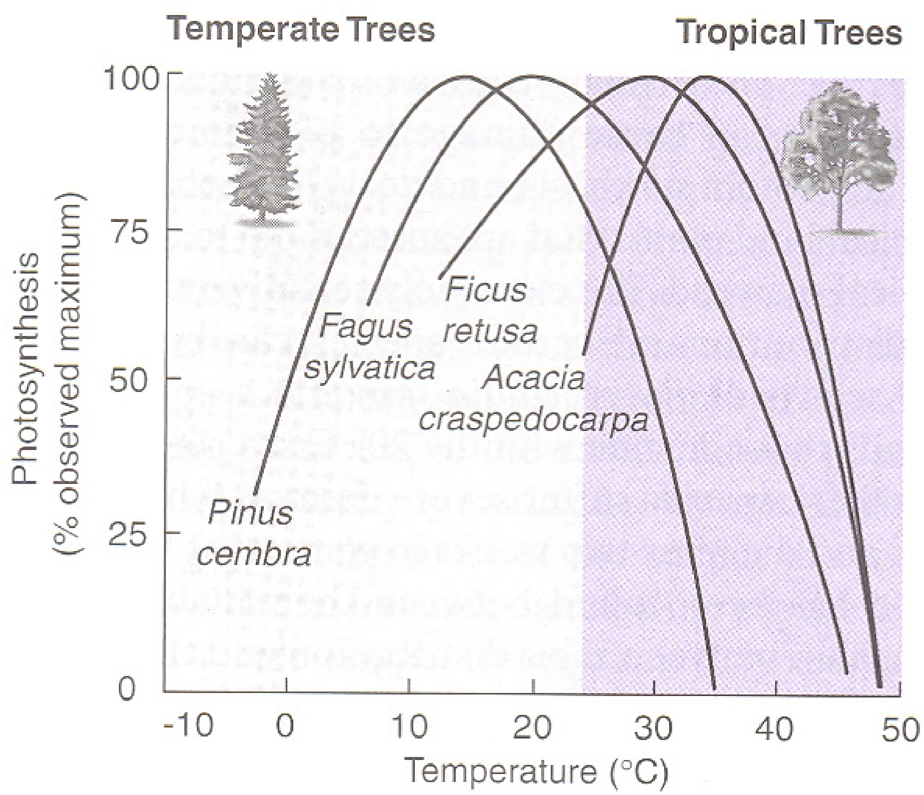


FIGURE 3.3 The relationship between temperature and rate of photosynthesis (after Larcher, 1969; Kramer and Kozlowski, 1979).

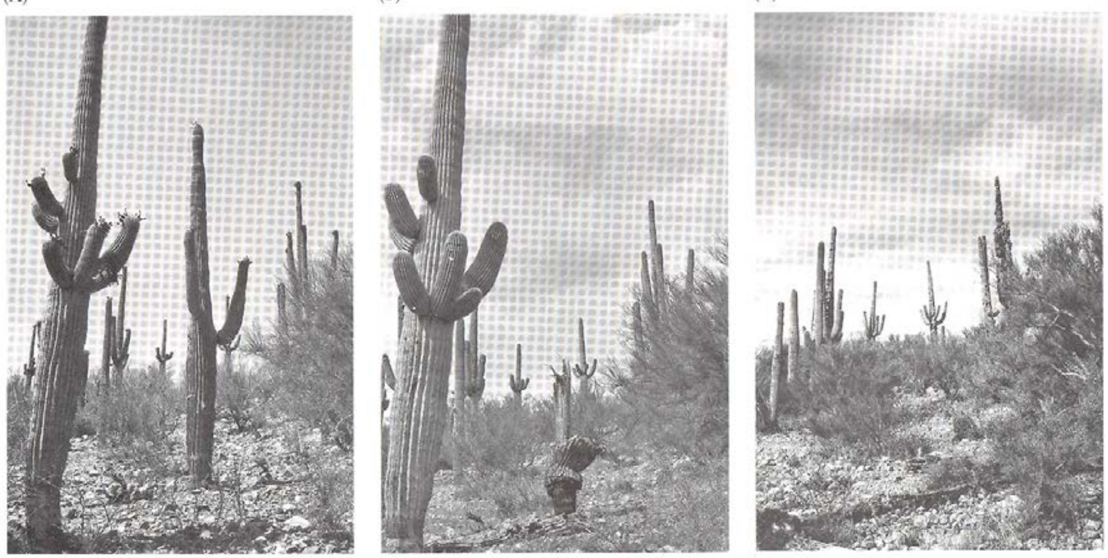
Physical environment

Temperature and the saguaro cactus (*Carnegiea gigantea)*

FIGURE 4.19 Matched photographs of a stand of saguaro cacti near Redington, Arizona, near the upper elevational and northern edge of the species' range. (A) In 1961. (B) In 1966, showing the loss of one large individual (center foreground) and scars (white patches near tips of arms) on several other cacti as a result of severe frost in 1962. (C) In 1979, showing much additional mortality due to severe frosts in 1971 and 1978; several of the individual cacti still standing are dead or dying. (A and B courtesy of J. R. Hastings; C courtesy of R. M. Turner.)

Frost damage in 1962:

(A) 1961 (B) 1966 (C) 1979



0 deg C for >24 hours

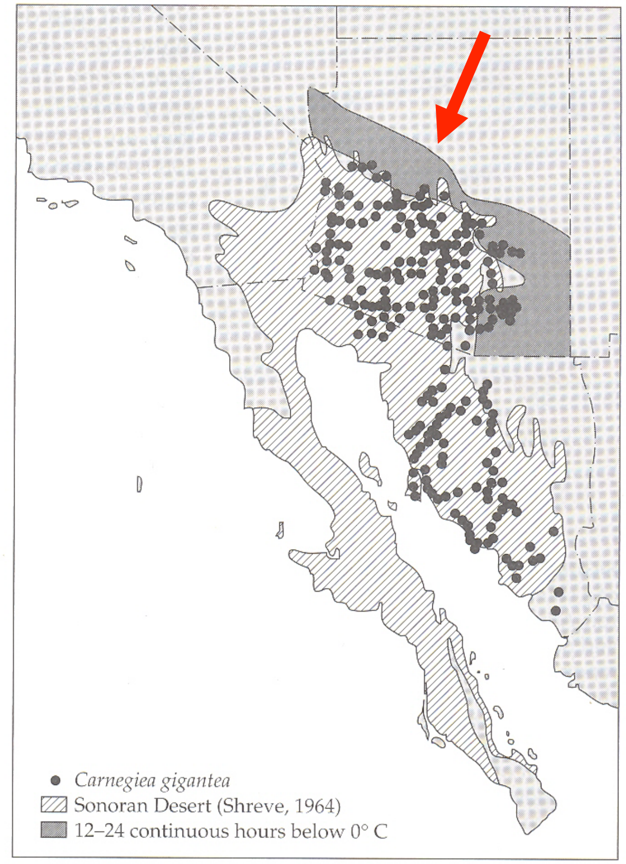
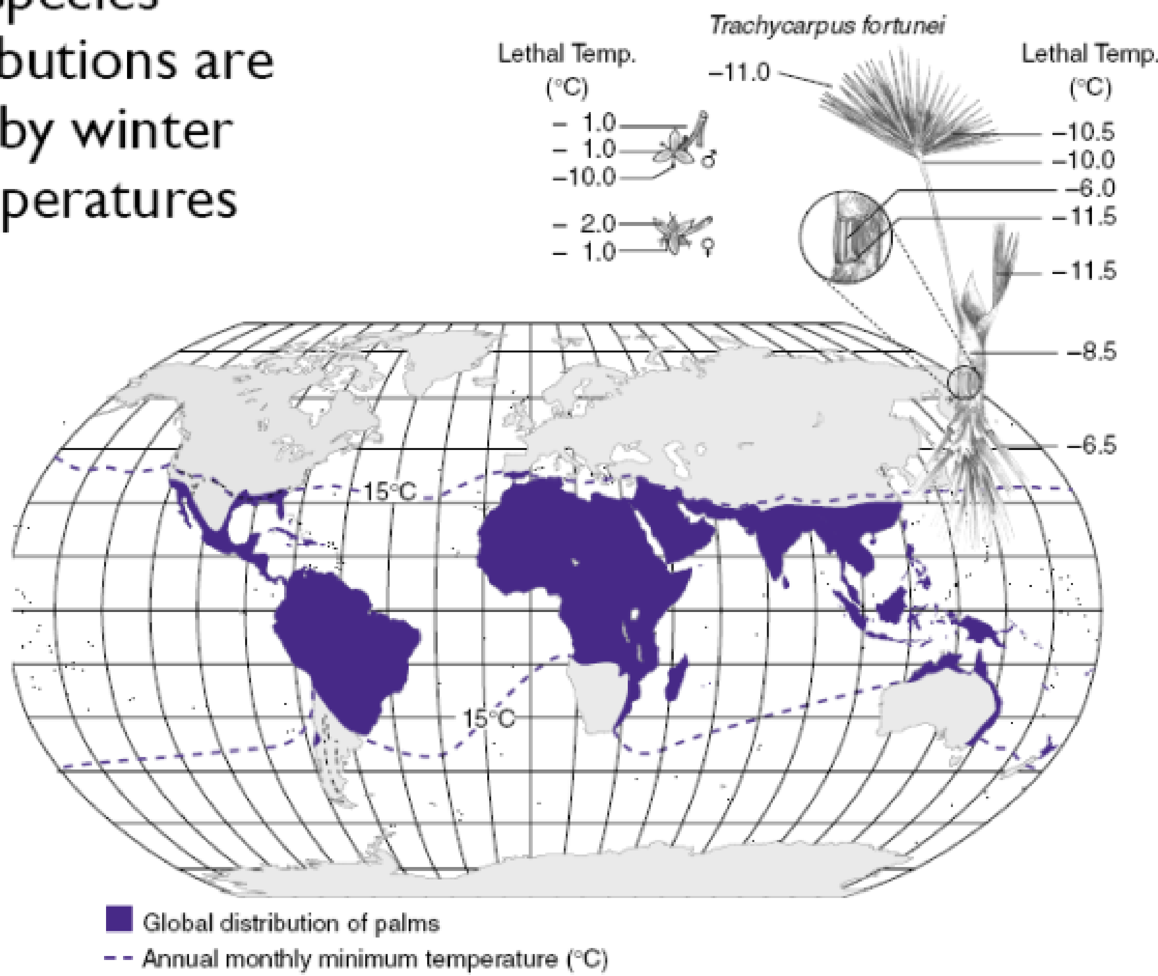


FIGURE 4.18 Distribution of the saguaro cactus (*Carnegiea gigantea*) in relation to winter temperature regime. This cactus, like many other Sonoran Desert plants, is intolerant of prolonged freezing. Note the close correspondence between the northern limit of the saguaro, the northern boundary of the Sonoran Desert, and the region where temperatures remain below 0° C for more than 12 hours. (Data from Hastings and Turner 1965; Hastings et al. 1972).

Physical environment

some plant species distributions are set by winter temperatures



Slide courtesy of C. Still

Physical environment

other plant species distributions are set by summer temperatures and the length of the growing season

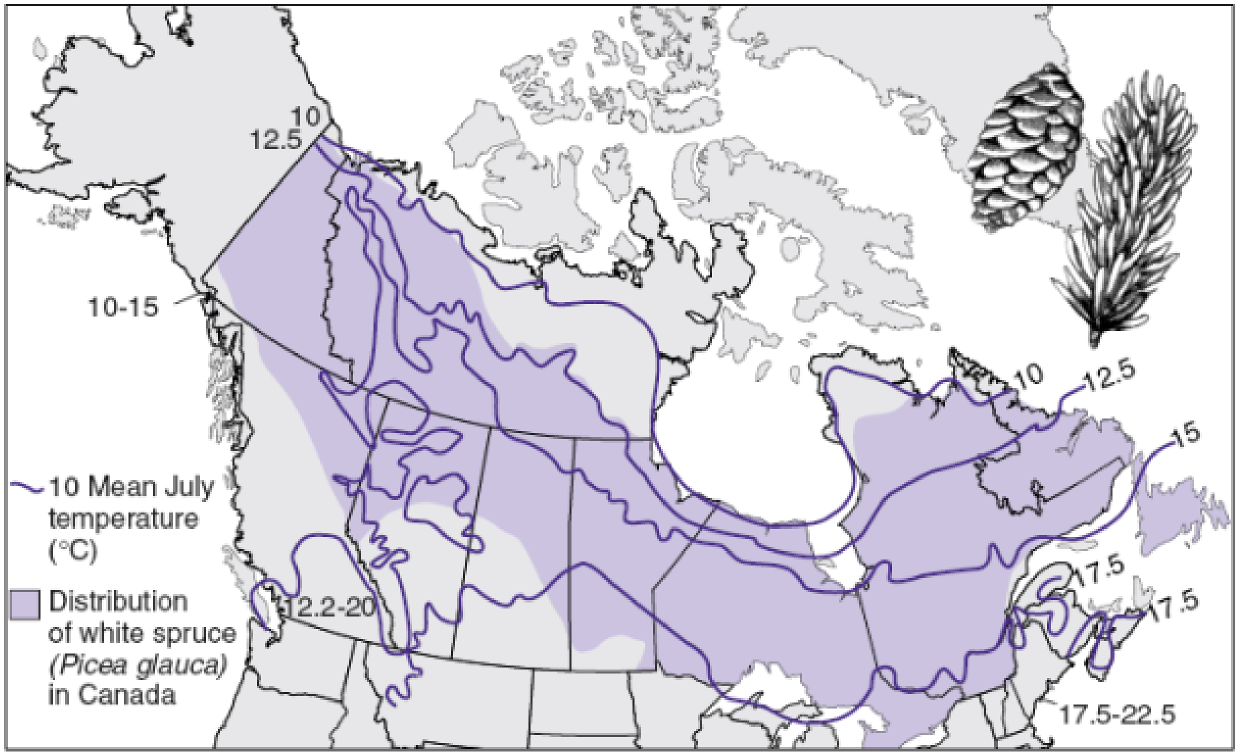
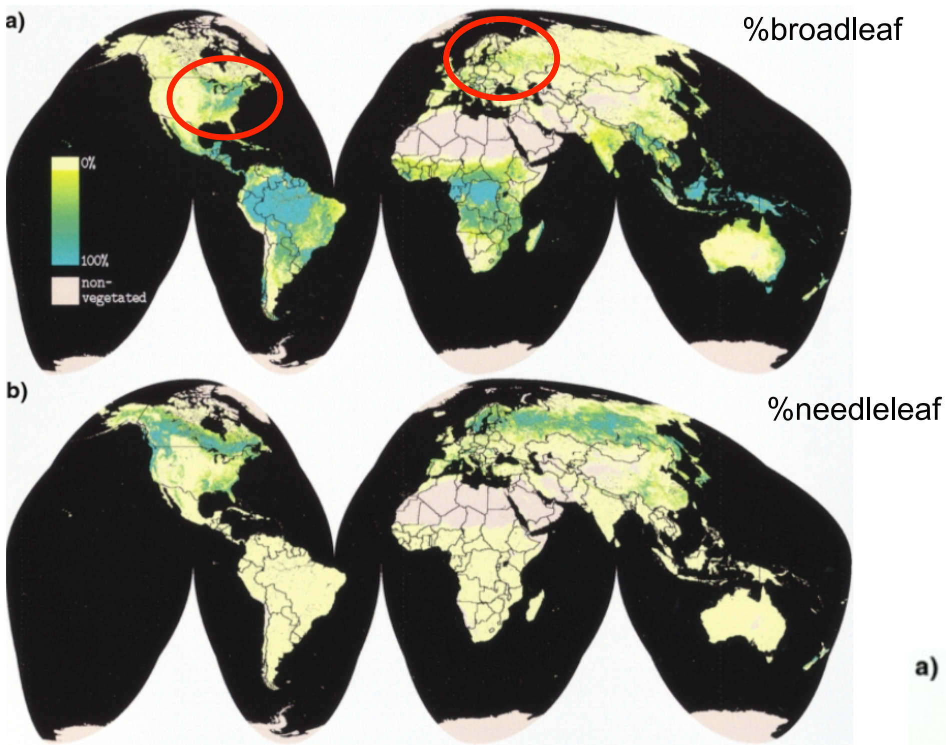


FIGURE 3.4 The relationship between the northern limits of spruce and July temperatures in Canada.

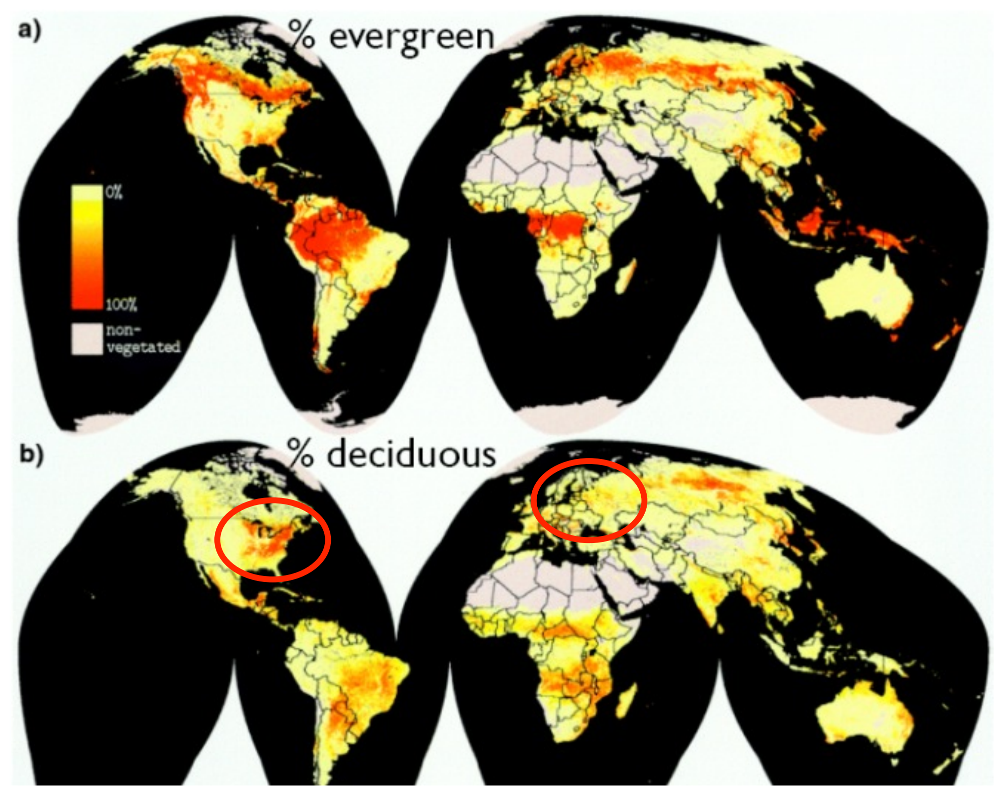
Slide courtesy of C. Still



Adaptations to cold:

- most extratropical broadleaf trees are deciduous

- in coldest areas, trees are evergreen needleleaf (conifers)

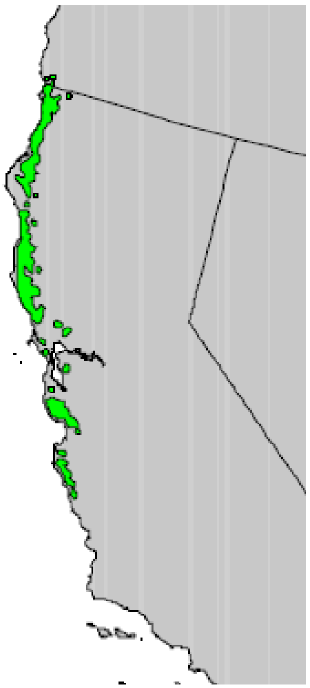


DeFries et al., 2000

Physical environment

But, not all conifers are resistant to cold, and not all deciduous trees are intolerant to cold

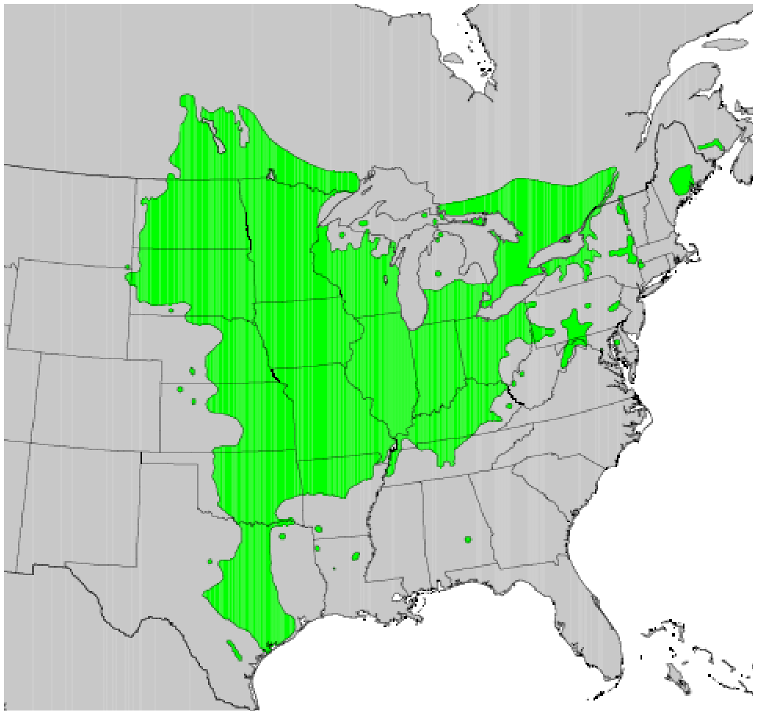
Redwood (*Sequoia sempervirens*)



Northern, upper elevation limit is -15 to -25 deg C

esp.cr.usgs.gov/data/atlas/little

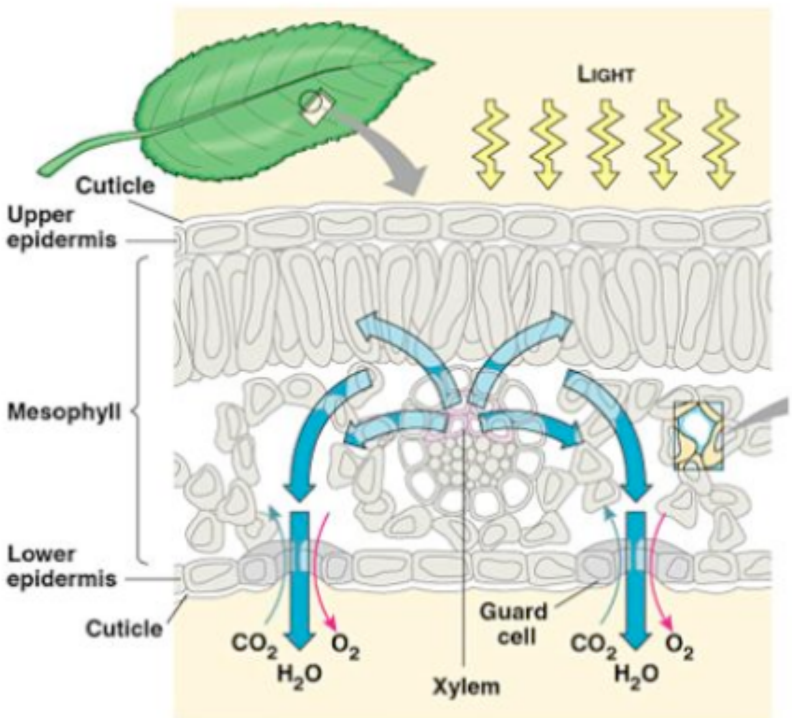
Big-leafed (bur) oak (*Quercus macrocarpa*)



Can withstand -60 deg C

Physical environment

Transpiration – Evaporation of Water from Leaf Surfaces



Water from xylem enters air spaces of the leaf and also diffuses into mesophyll cells.

Water exits the leaf by diffusion mainly through stomata, which open and close in response to environmental and internal signals.

A small amount of water (<5%) can also diffuse through the epidermis.

Transpiration cools the leaf due to evaporative cooling.

Image credit: http://www.ualr.edu/~botany/transpiration.jpg

latent heat of evaporation = 2510 J/g at 0 °C

Slide courtesy C. Still

Physical environment

Temperature affects sex ratio of turtle hatchlings

Table 1. Sex ratios of hatchling turtles. The question mark indicates sex unknown: infertile, or dead at early stages.

Sex	Experiment 1		Experiment 2		Experiment 3	
	25°C	30.5°C	20° to 30°C	23° to 33°C	Shade (13)	Sun
			Graptemys ouachitensis			
Male	210	0	73	0	100	4
Female	0	211	0	65	0	123
?	23	26	38	44	101	74
			Graptemys pseudogeographica			
Male	173	4	43	0	35	1
Female	0	147	0	43	0	19
?	49	81	20	24	10	25
			Graptemys geographica			
Male	98	0			37	0
Female	0	88			0	15
?	24	31			12	36
			Chrysemys picta			
Male	81	0				
Female	0	81				
?	21	20				
			Trionyx spiniferus			
Male	33	27				
Female	34	24				
?	16	35				

Implications of global warming?

Bull and Vogt, 1979

Physical environment

Animals: Temperature effects on distributions

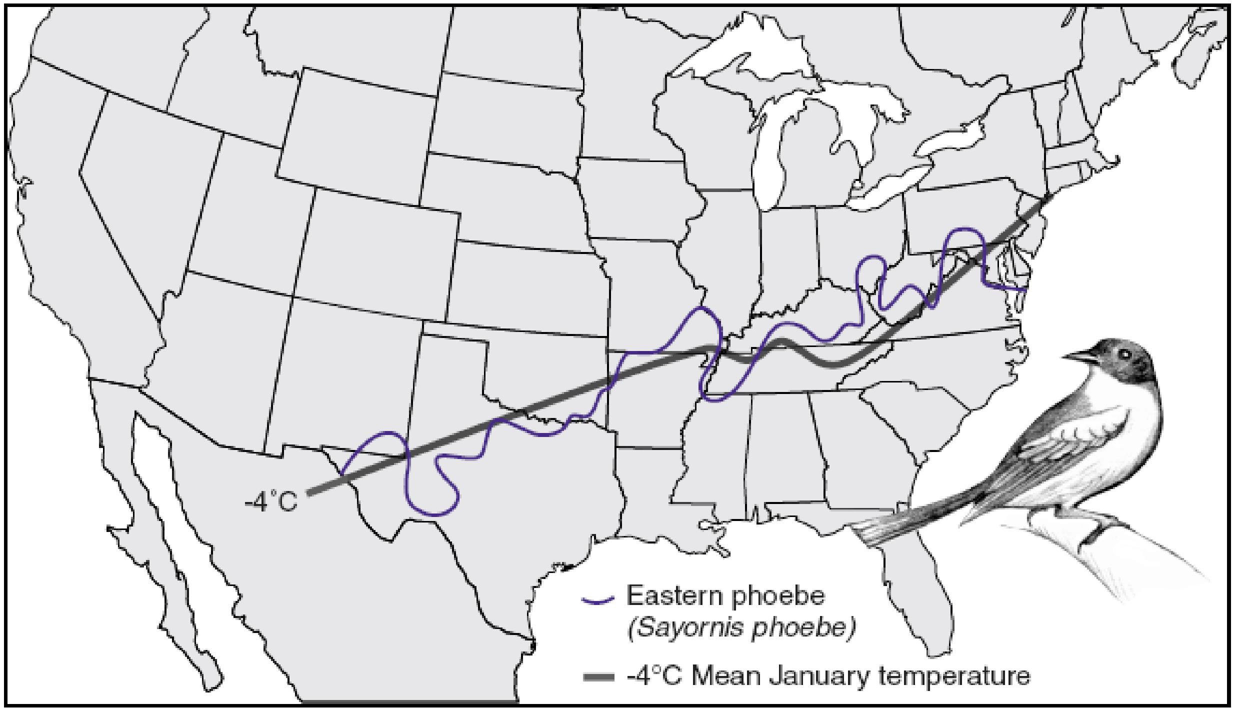


FIGURE 3.8 The relation between January temperature and the northern limits of the eastern phoebe *(Sayornis phoebe)*. North of the –4° C January isotherm, the birds cannot obtain food in sufficient quantities to support the metabolic activity required to maintain their body temperature above lethal levels (after Root, 1993).

Physical environment

Animal behavior adaptations

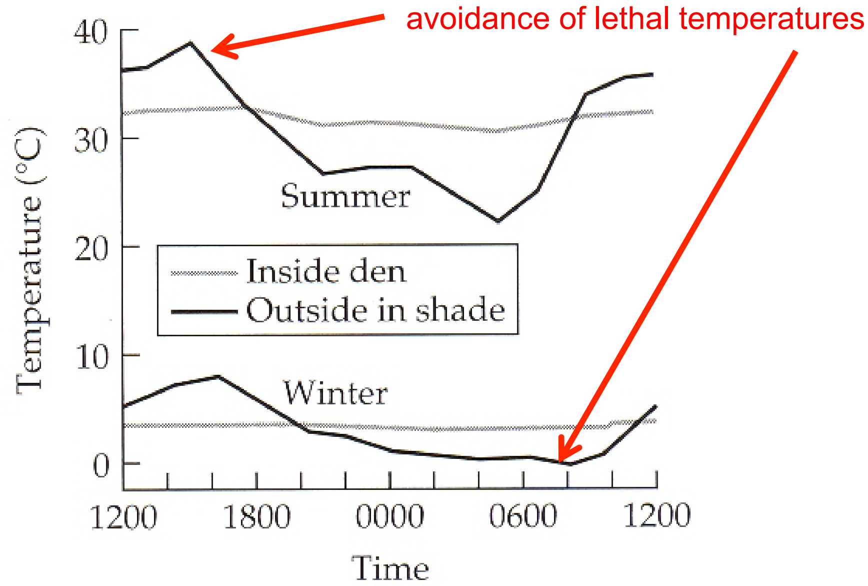


FIGURE 3.18 Temperatures inside and outside the den of a bushy-tailed woodrat (*Neotoma cinerea*) and a deep crack between large boulders in the high desert of southeastern Utah during midsummer and midwinter. Because the den (where the animal spends most of its time) experiences much less variation than the macroclimate outside, it affords vital protection from stressfully high and low temperatures in summer and winter, respectively. (After Brown 1968.)

Lomolino et al. 2006

Physical environment

Allen's Rule - the length of extremities like ears and arms decreases with temperature

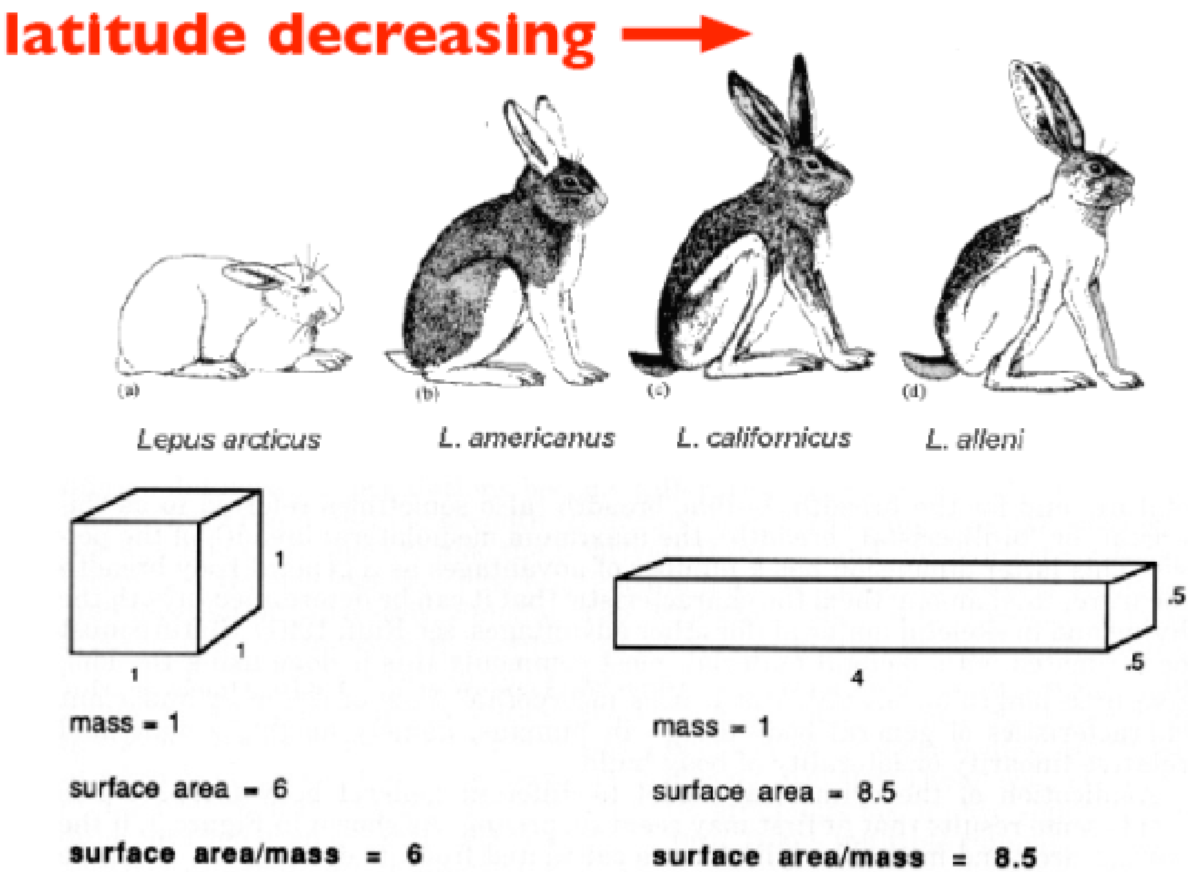


Illustration ofAllen's Rule from Ruff (1994:71)

Figure credit: http://www.mun.ca/biology/scarr/Lepus_variation.gif

Slide courtesy C. Still

Physical environment

Animals: Temperature adaptations to cold

Physiology

Cold hardening of mountain pine beetle

Decrease of supercooling point as winter progresses

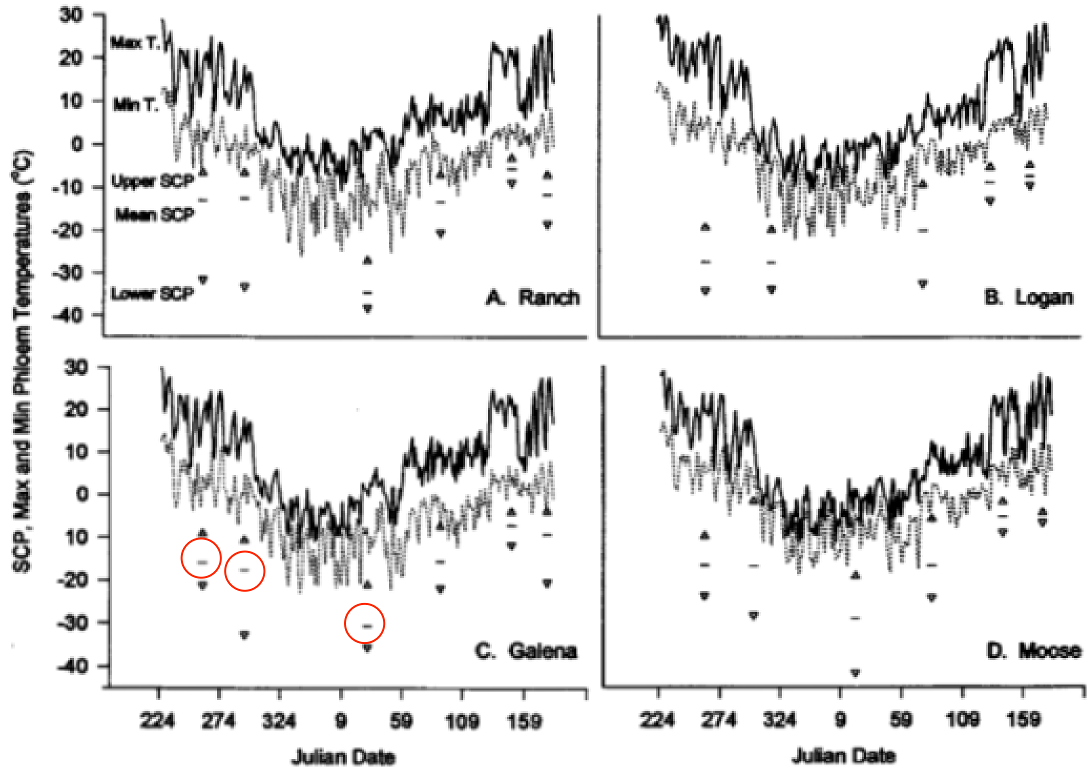


Fig. 1. Maximum and minimum phloem temperatures (T, °C) at 4 sites (A–D) in 1992–1993 with the mean (—) and range (△, ▽) of associated larval supercooling points (SCP) (°C).

Bentz and Mullins, 1999

Physical environment

Animals: Temperature adaptations to heat

Morphology

"Cool" adaptations to hot conditions

Elephant (*Loxodonta africana*)

fohn.net/elephant-pictures-facts

Chameleons (*Chamaeleo*)

www.african-safari-journals.com/chameleon-pictures.html