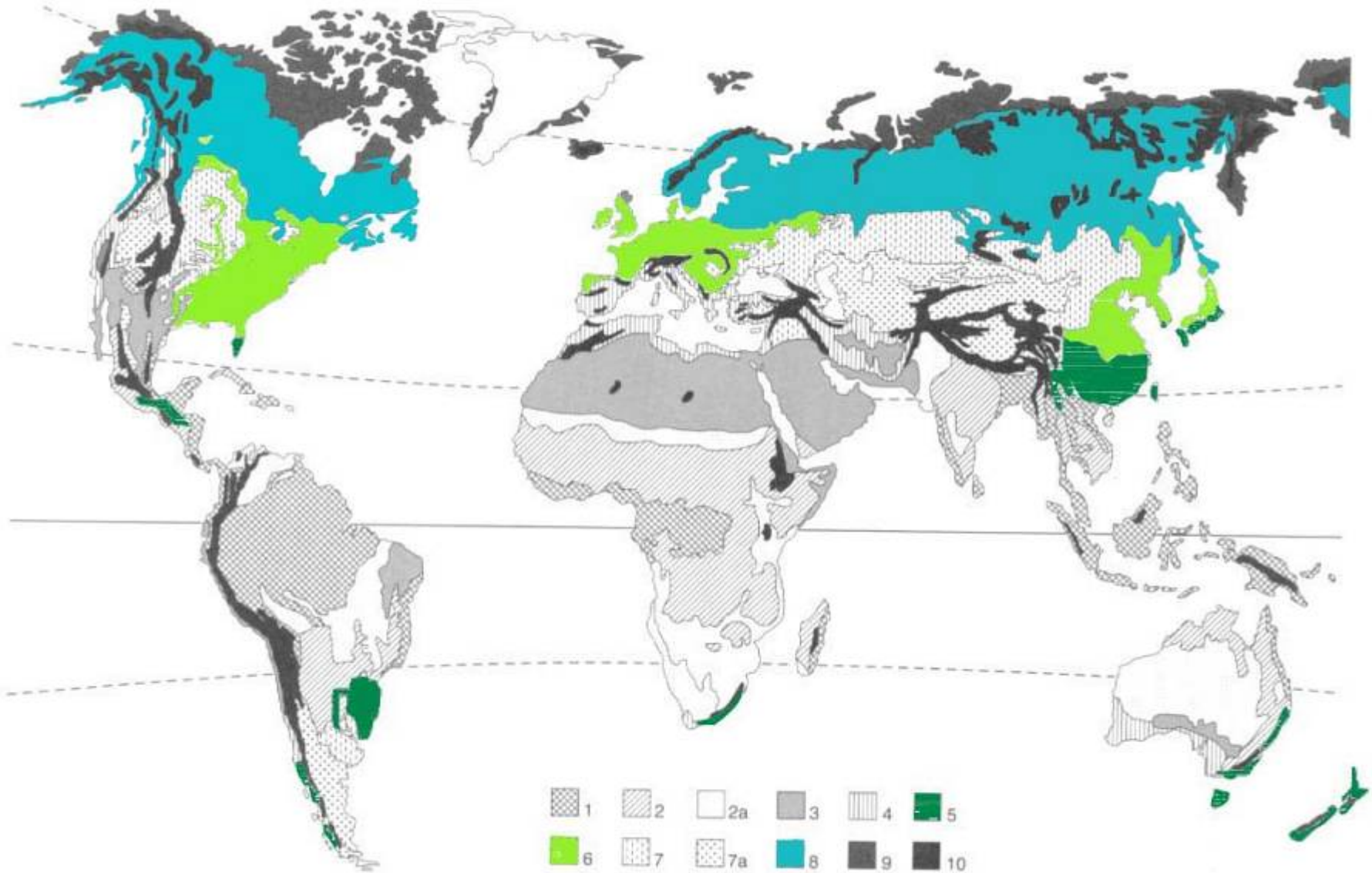
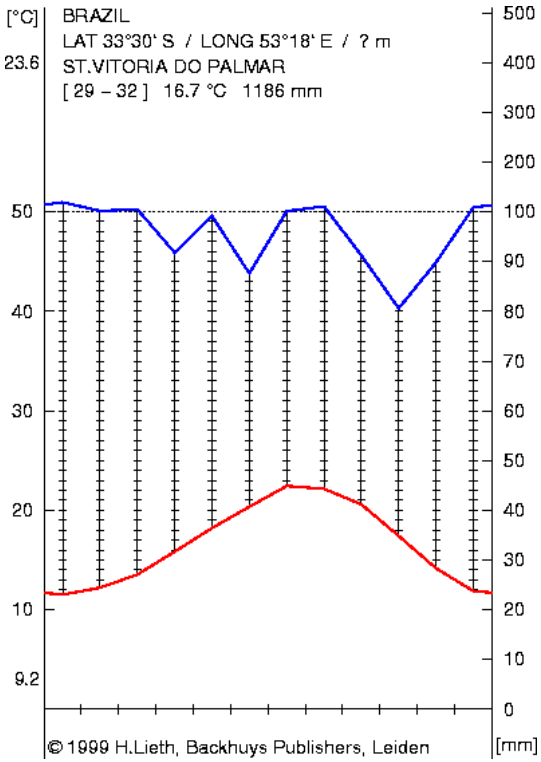
Temperate Evergreen Forest, Temperate Deciduous Forest, Boreal Forest

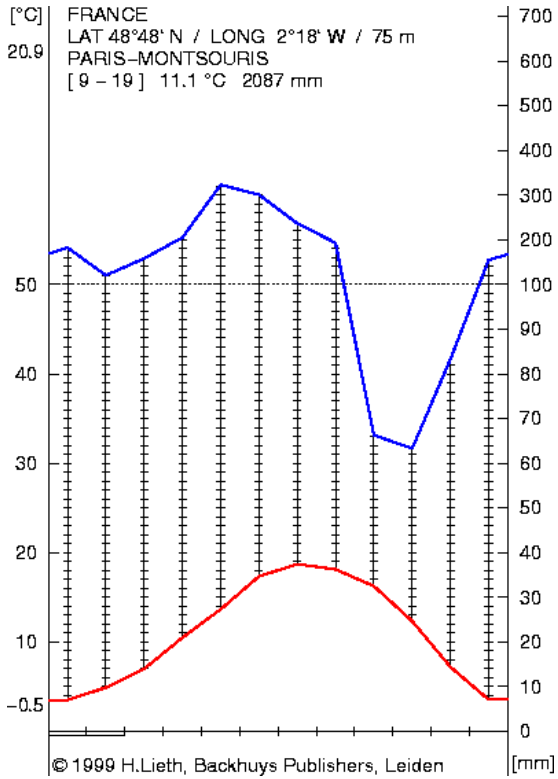
Lectures 11 & 12

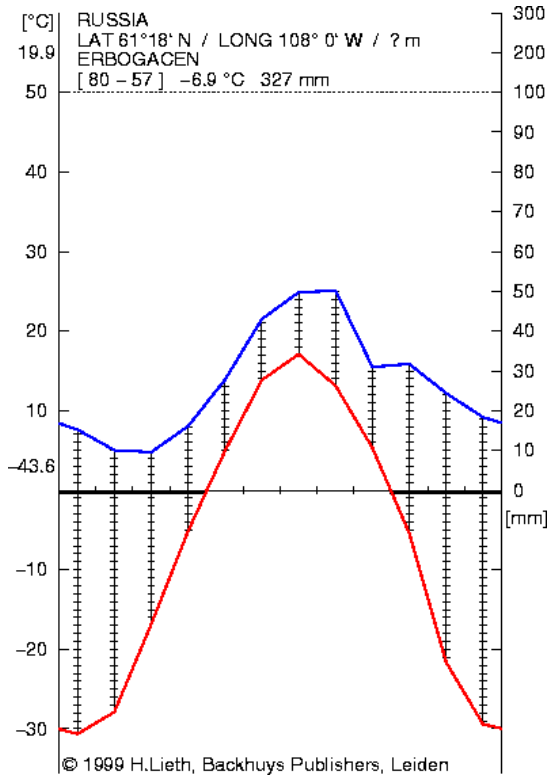
Distribution of Temperate Evergreen Forest (5), Temperate Deciduous Forest (6), and Boreal Forest (8)



A tale of three climographs and three leaf forms







Some drought tolerance

Temperate Evergreen leaves are generally thick and have smooth margins (Bouganvilia)

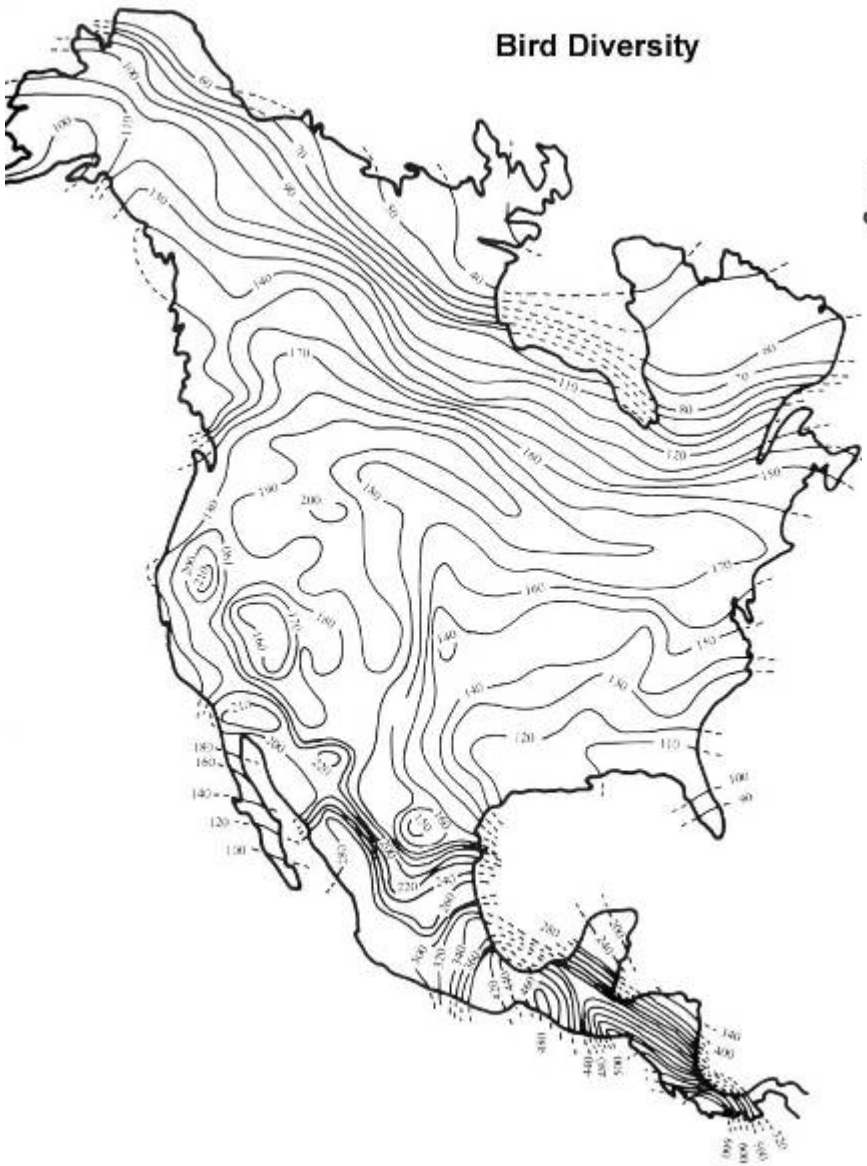
Little drought tolerance

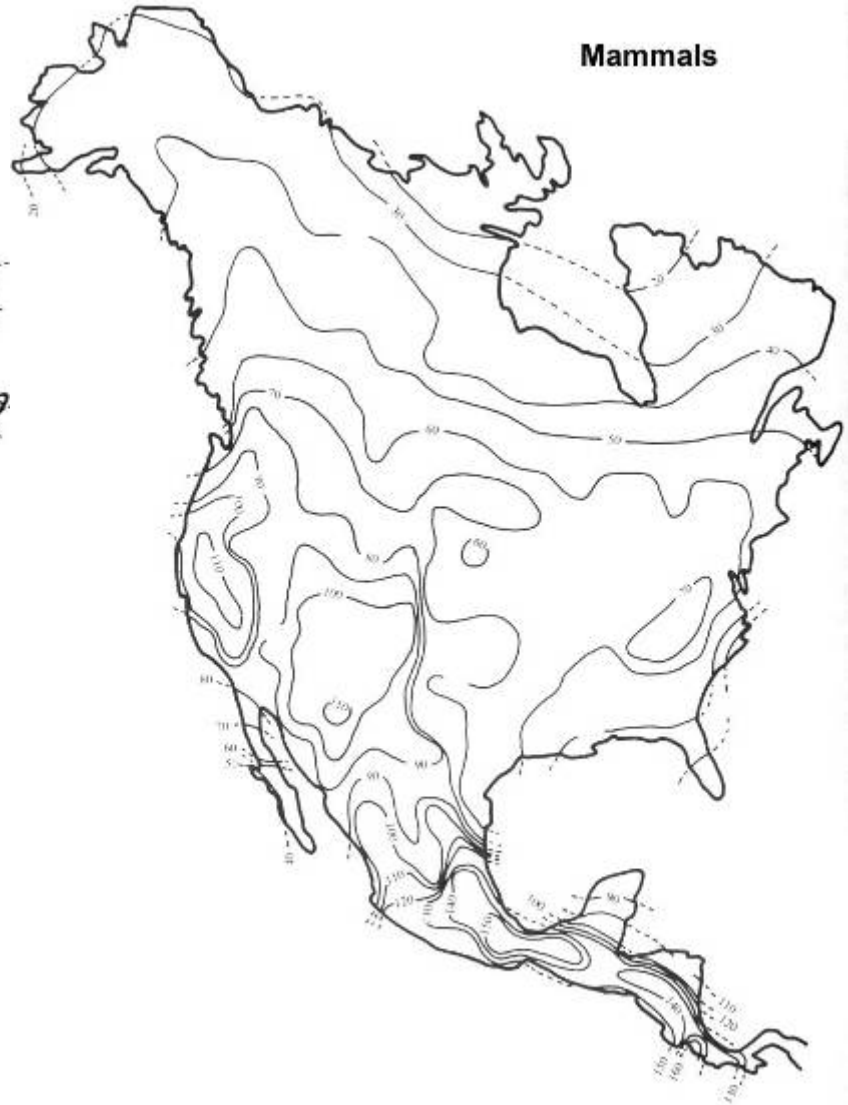
Temperate Deciduous leaves are generally thin and toothy (Maple)

Considerable drought tolerance!

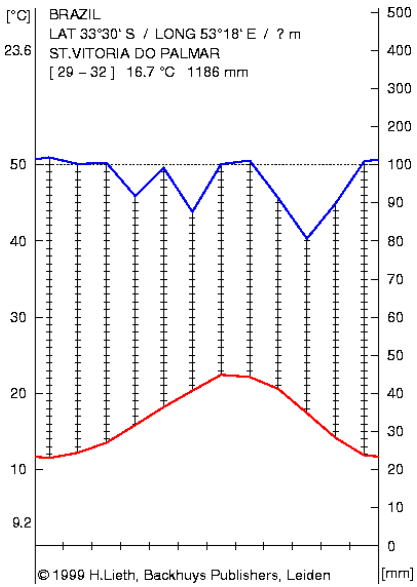
Boreal Forests are dominated by conifers with evergreen needle leaves (Spruce)

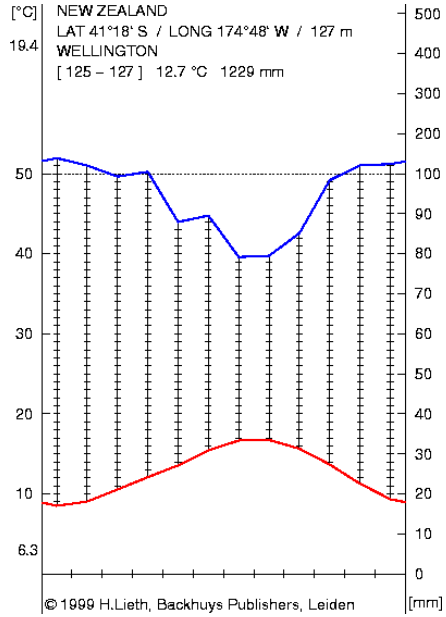
An important aside: patterns of biodiversity. In many but not all cases, the number of species is greatest in the tropics and declines toward the poles. Mountainous areas like California get a boost in species because of the altitude and topographic niches they create. Notice how extreme this gradient is in the case of birds. Tiny Costa Rica has several times as many species as much larger California. Ecologists and evolutionists still debate the causes of the diversity gradients.

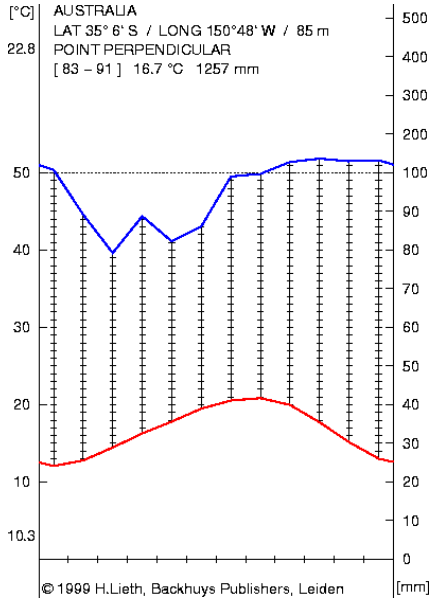


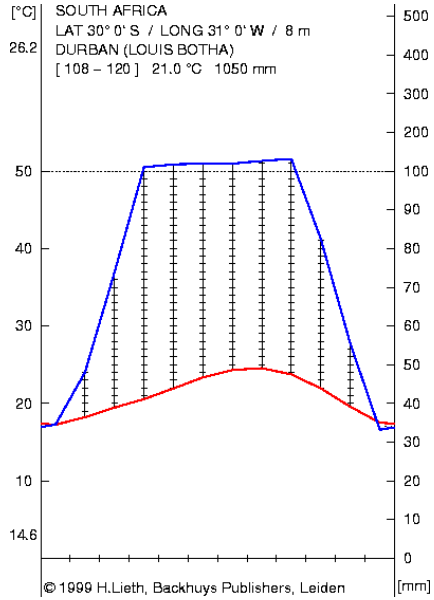


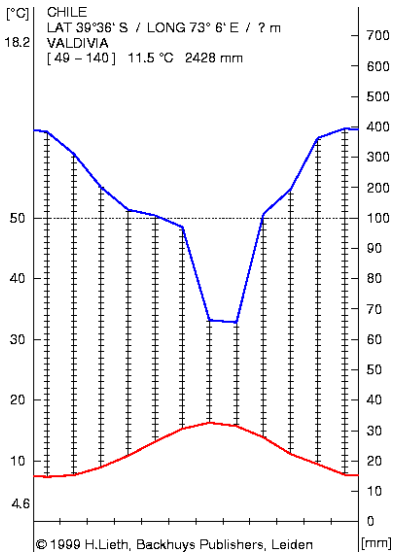
Climographs for Temperate Evergreen Forests. Note variation. Newport, Oregon, Walter once mapped as Biome 5, but later switched such climates In Western North America to biomes 4 or 8. Lines on maps!

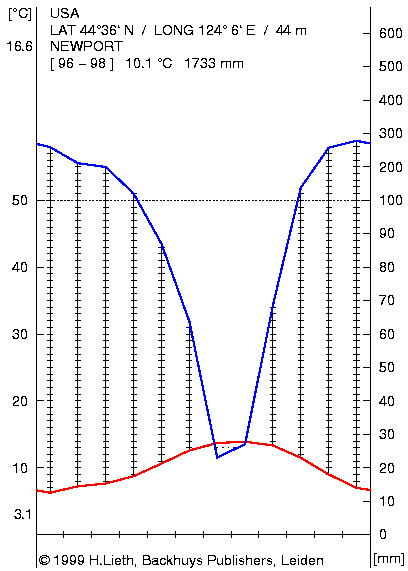


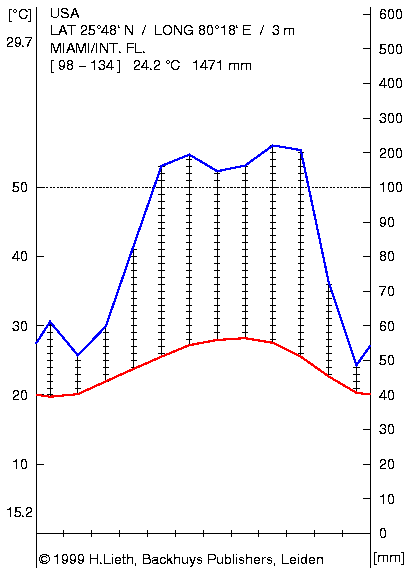


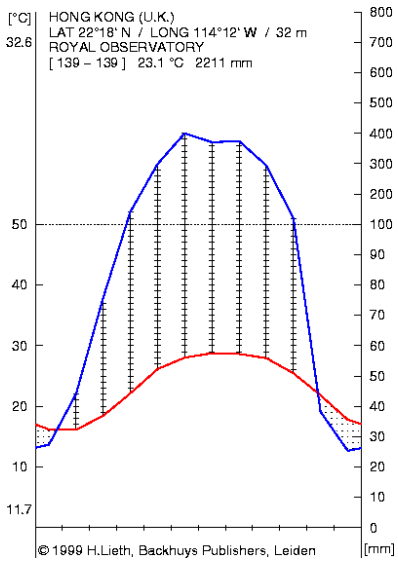




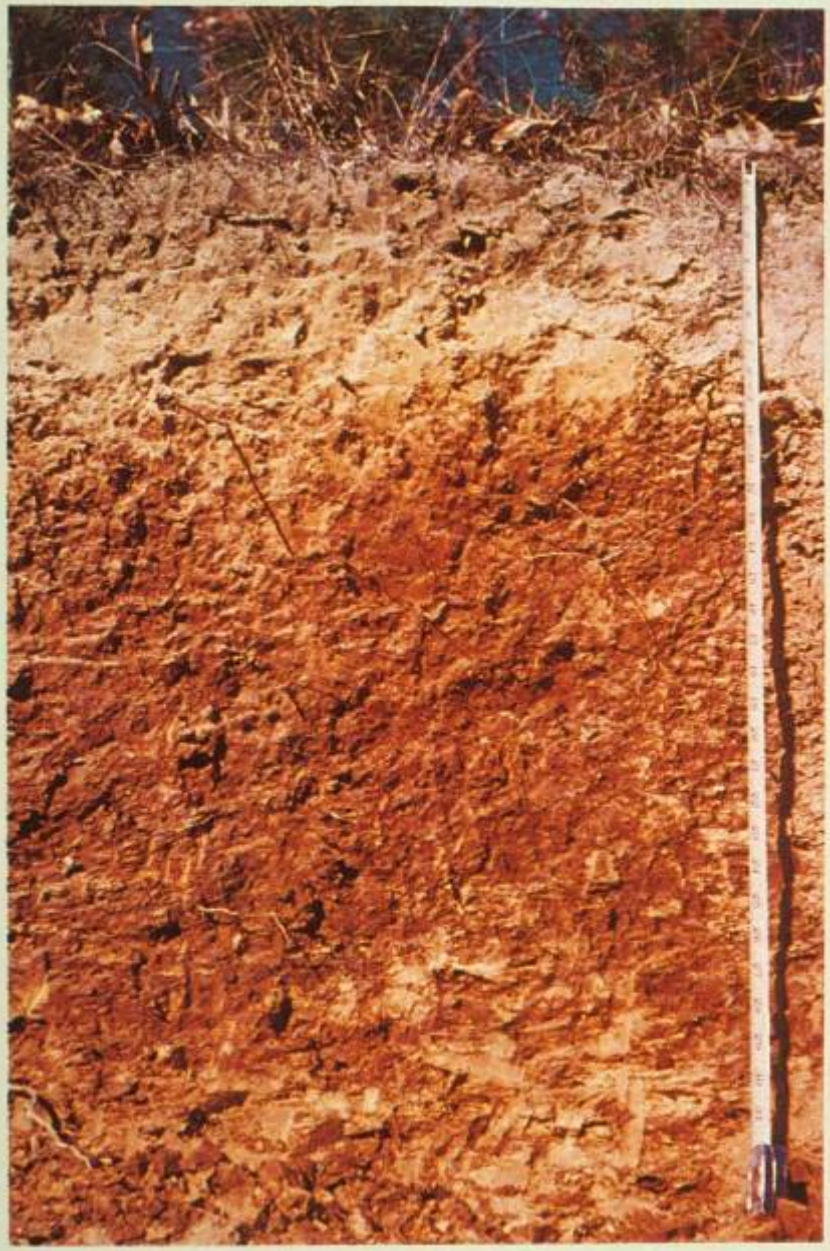






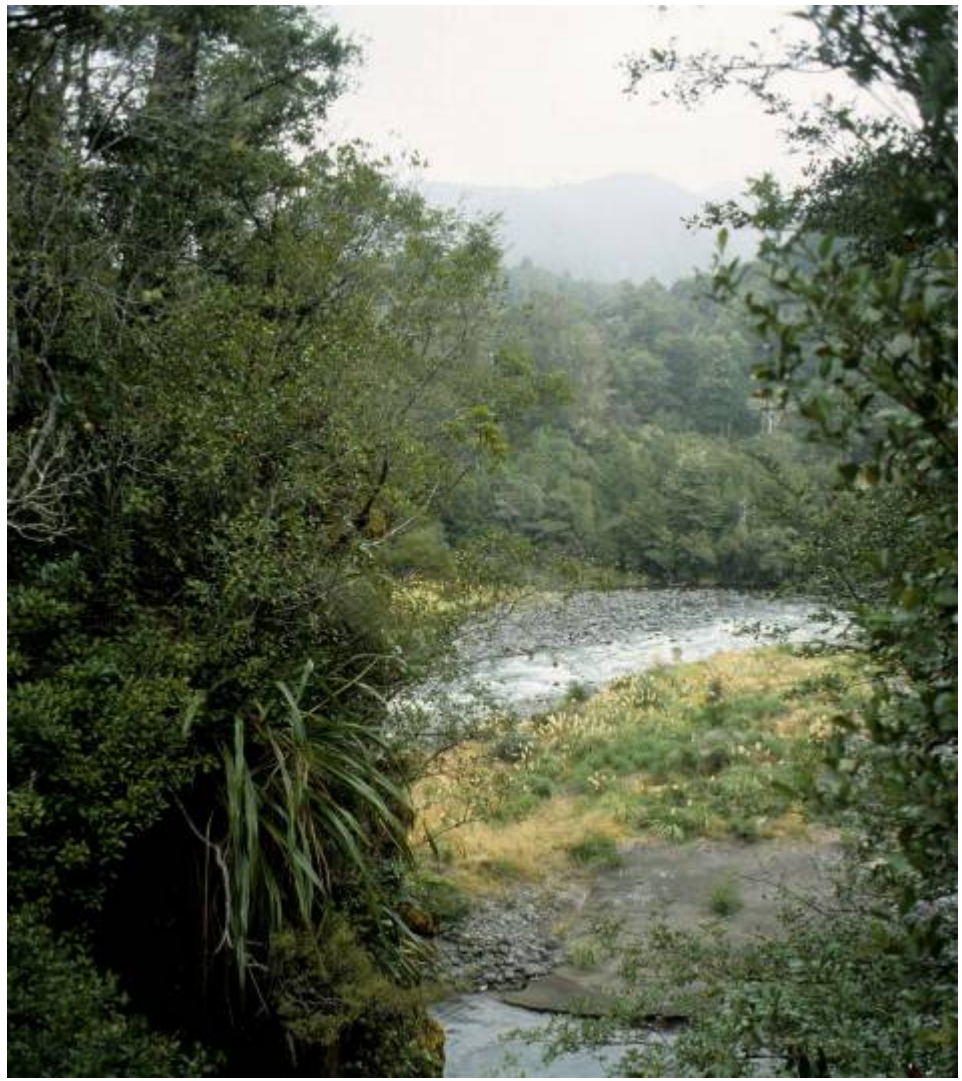


In the Temperate Evergreen Forest and in the warmer parts of the Temperate Deciduous Forest, soil weathering processes are quite active. Typically, clays are not as highly weathered as in Oxisols of Biomes 1 and 2, but the clays that remain in “Ultisols” have lost much of their base exchange capacity and have been moved out of the surface layers of the soil.



9. Ultisols—a Typic Hapludult from western Arkansas.

Temperate Evergreen Forest in New Zealand. Tree ferns are an important exception to the smooth-margined leaves generalization.

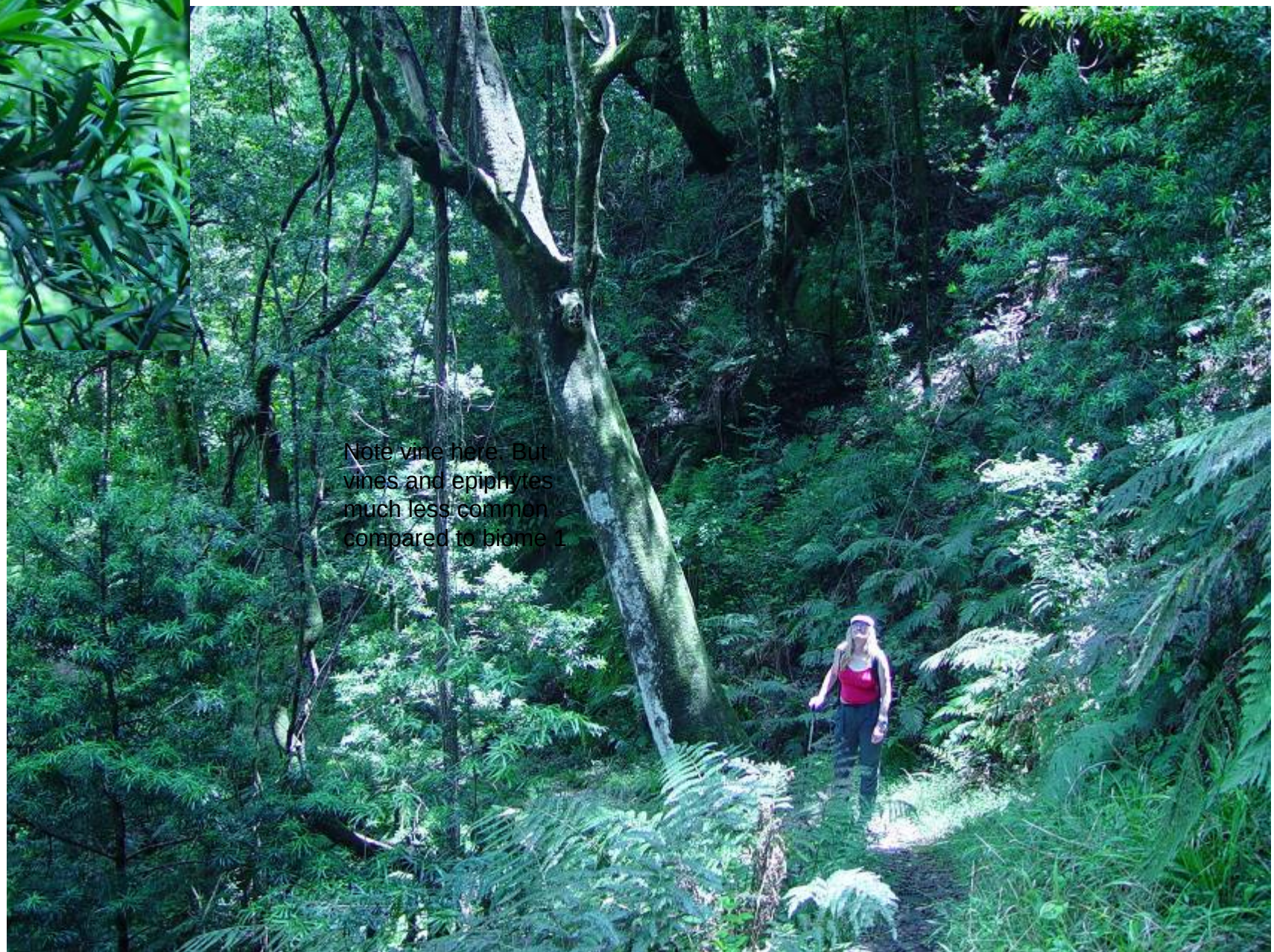


Biome 5 on the south coast of South Africa. As the summer rain picks up east of Cape Town, a thick scrub of small evergreen trees occurs. Note the Biome 2a like grassland on the plains and the tall Biome 3 like Euphorb above my wife's head. A complicating factor here is fire. South African farmers and pastoralists are enthusiastic users of fire, converting Biome 5 like landscapes into Biome 2a like landscapes.

Drakensberg landscape. The general aspect is like Savanna (Biome 2a) or even Steppe (Biome 7). But human burning is very important in shaping this landscape. Note the burned remnants of shrubs in the foreground and patches of woody vegetation in the background.

Drakensberg mountains, South Africa, well into biome 2a as it is usually mapped. This landscape is burned every few years, but isolated Biome 5 plants persist in the open, like this tree fern. The draws are moister and harder to burn. Here plants very characteristic of Biome 5 dominate. These confusing in-between landscapes Walter called “zonoecotones.” “Ecotone” is the ecologists term for the boundaries between communities.

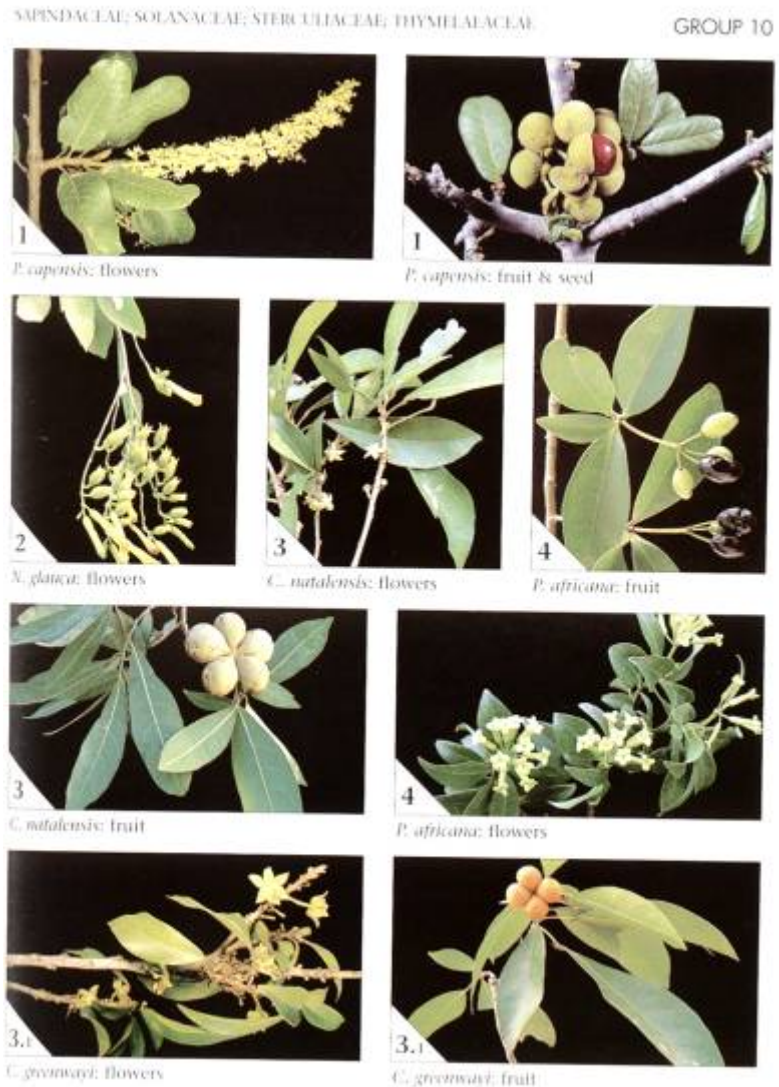
Yellowwood Forest in South Facing Canyon in Drakensbergs. Tall evergeen forest that could hardly be more typical of Biome 5! The trees here are Podocarps (Yellowwood). These plants are in the same general group as our pines.



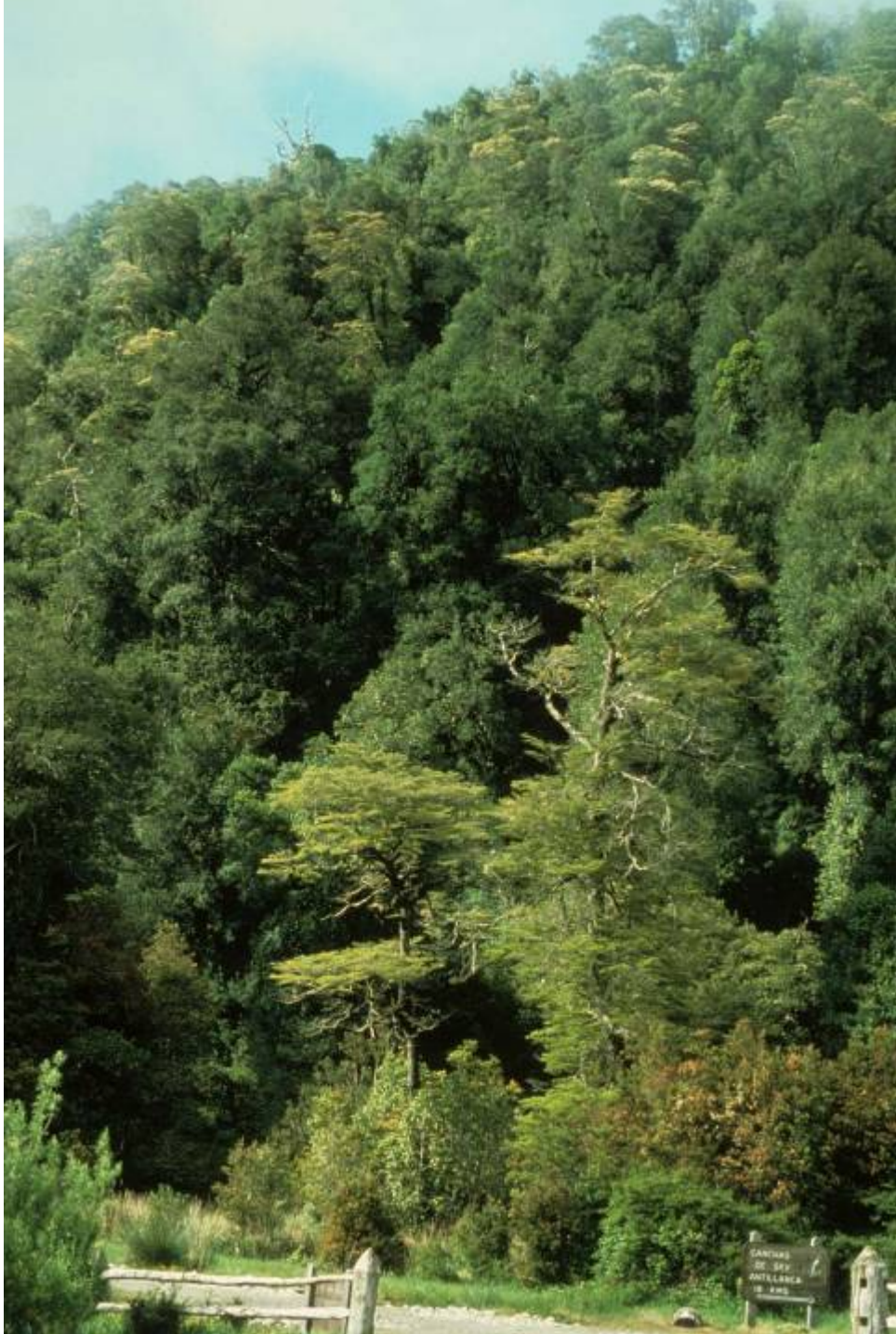
Looking up into the canopy of a New Zealand example of Biome 5. In contrast to an Evergreen Tropical Forest, note the lack of vines and epiphytes. In contrast to Temperate Deciduous Forest, note small leaves with smooth margins.

Nothofagus branch with small smooth margined leaves, New Zealand. Like the Podocarps are distantly related to our pines, Nothofagus is distantly related to the Northern Hemisphere Oaks. Seafloor spreading events are correlated with these distant relationships.

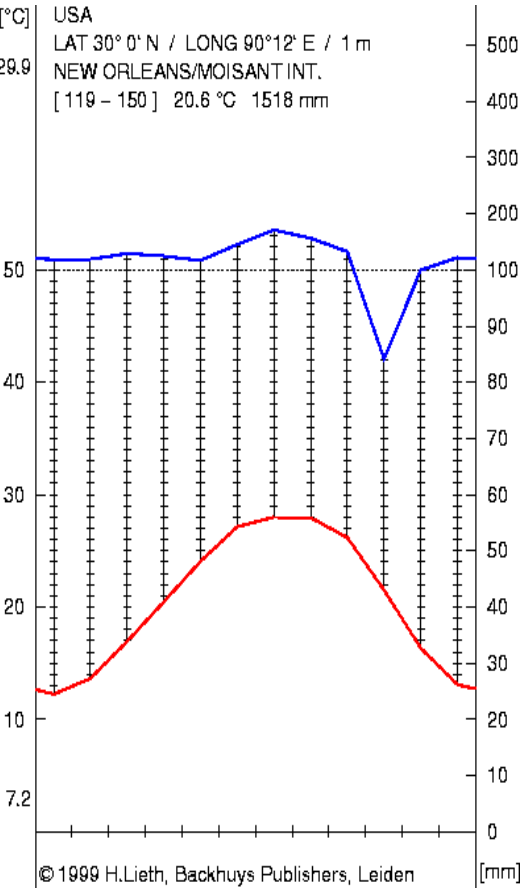
More or less random page from a field guide to the trees of South Africa showing a selection of smooth-margined leaves. Some leaves in this guide show small teeth and other deviations from the pattern, but not very many. Generally, the leaves of Biome 1 trees are larger than those of Biome 5.



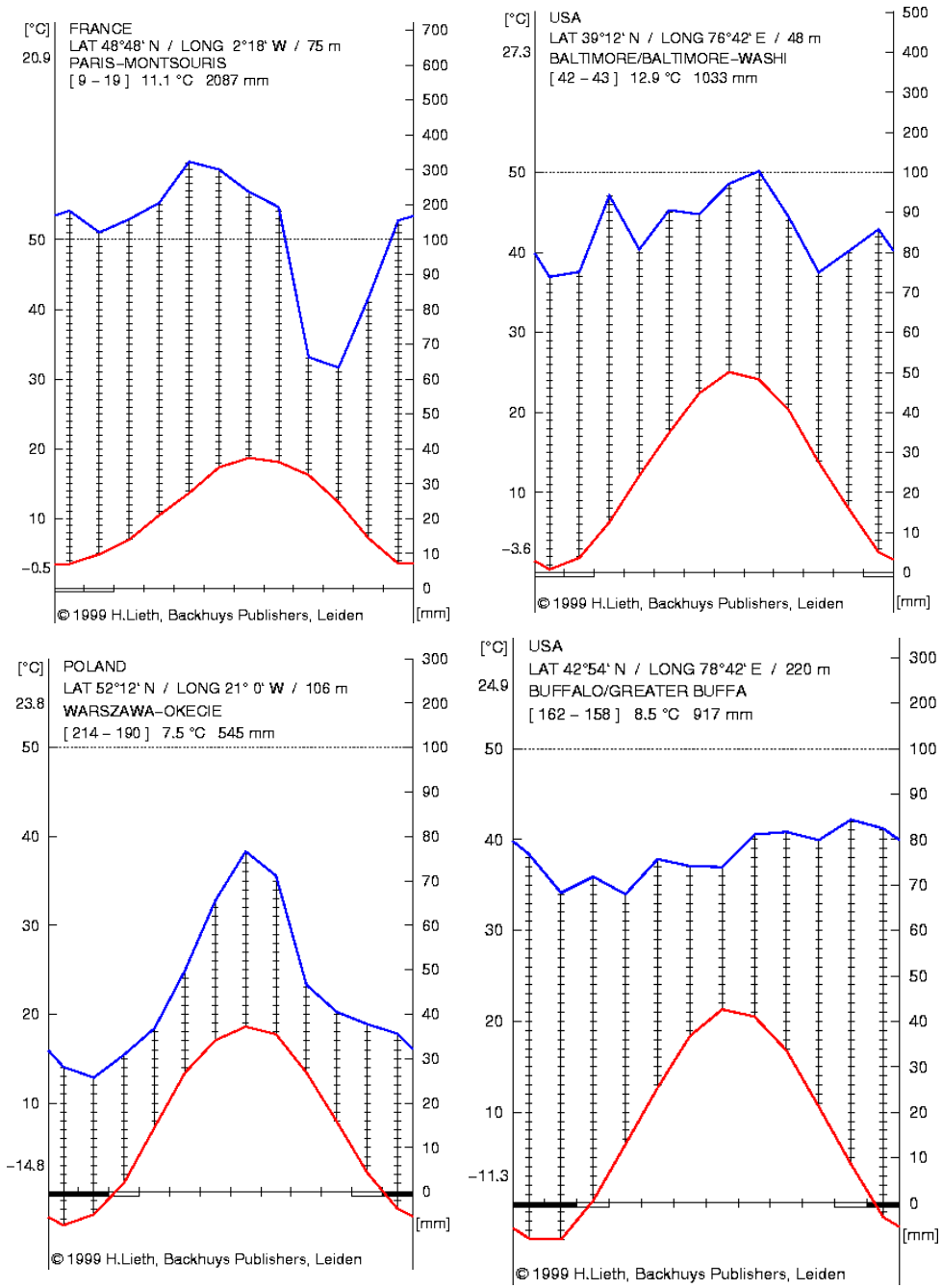
Nothofagus dominated forest from Biome 5 in Chile. The Podocarps and Nothofaguses are but a sample of plants and animals that are common to South Africa, New Zealand, Australia and South America. These continents were linked to Antarctica until 80 million years or so ago and they share many elements of their flora and fauna. The biotic evidence like this was advanced by Alfred Wegner and other early proponents of continental drift. Today, the resistance to his theory seems hard to explain.



A little biogeographic puzzle: Virginia Live Oak at the Battle of New Orleans Battlefield Park (War of 1812). The Southeastern US has a number of plants very reminiscent of Biome 5 but is dominated by Biome 6 plants down approximately to the middle of Florida, as we see on Walter's map. The New Orleans climograph seems to indicate a homoclimate similar to Southern Brazil. No frost and freeze lines indicated for example. The clue, I think, is that Citrus cannot be grown reliably except in the south half of Florida. The reason is not the mean temperature in any given month but that every decade or so powerful cold storms sweep down out of Canada and bring frost and even snow clear to the Gulf of Mexico. Only hardier than usual evergreens like Virginia Live Oak and Magnolia survive the rare freezes.



Temperate Deciduous Forest Biome climographs. The top two are from more maritime climates, where winter cold is moderated by proximity to the relatively warm ocean in winter. Western Europe is especially favored in this way. Many Biome 5 plants grow fine in gardens in places like the South of England. Such places might map to Biome 5, except that they lack a historical source of Biome 5 plants but have a ready source of Biome 6 plants. The Gulf Stream keeps Western Europe quite warm at quite high latitude. The bottom two are from places further inland. Winters in Warsaw and Buffalo are fairly severe with plenty of winter snow in typical years. No Biome 5 plants here, outside of a greenhouse! But even in the more “continental” examples, the frost-free growing season is about 7 months. The American examples have especially hot, humid summers. Just as no mountain ranges protect the Eastern US from blasts of Arctic air from Canada in winter, so too no mountains keep the mid-latitude storms from drawing lots of hot moist tropical air from the Gulf of Mexico in summer. Physical as well as biotic differences generate appreciable diversity between different examples of the same biome.



Temperate Deciduous Forest just coming into leaf in spring. Near Ashville North Carolina

Elm leaves. Typical of the toothy pattern typical of the deciduous leaves of Biome 6 style plants. To the touch, these are paper napkin leaves, thin, cheap to produce, and adapted to move lots of water out of them in order to draw the maximum nutrients up from the roots during the summer. In the fall, the plant draws nutrients out of these leaves, often leaving behind brightly colored pigments of little value, giving the sometimes spectacular fall colors of the plants of this biome. (The function of these red and yellow pigments is to absorb light for photosynthesis at wavelengths that chlorophyll cannot).

Duke Forest (North Carolina). January on the left and early March on the right. As the days lengthen, the air close to the ground warms enough to support leaf-out before the tress can get started.

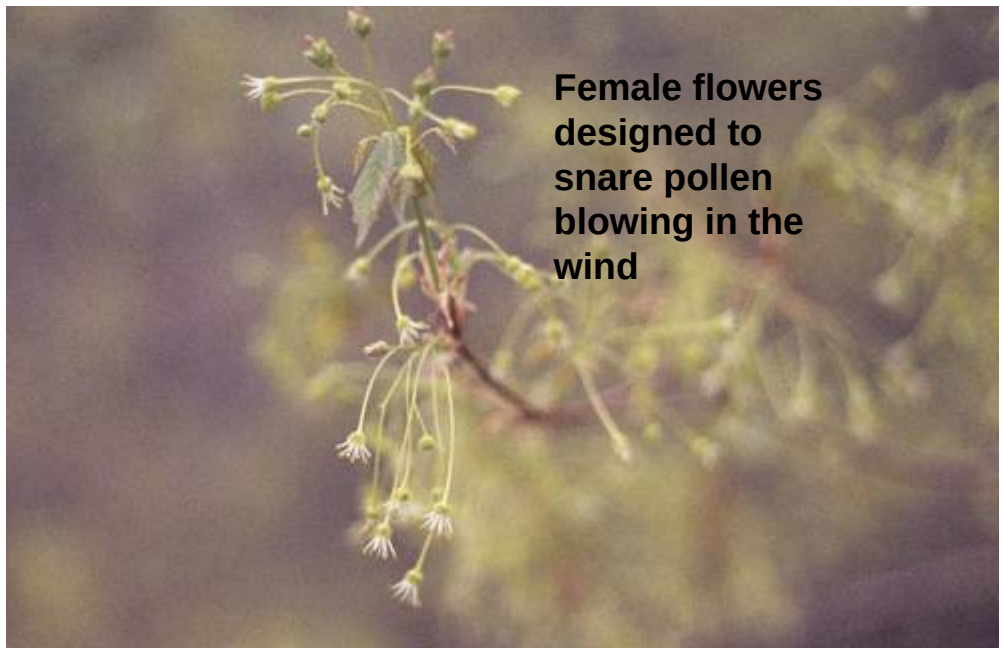
From early to late spring, the understory plants have enough light and enough warmth to thrive. The Temperate Deciduous Forest has many perennial herbs and shrubs adapted to exploit this niche.

Along towards mid spring, the canopy leaves are casting heavier and heavier shade onto the forest floor. The understory perennials and shrubs begin to go into low maintenance mode, and only the most low-light tolerant tree saplings can avoid losing energy and dying.

By summer, the forest floor is quite shady. Now the canopy trees are well decked out with leaves and are photosynthesizing like mad. The humid summers and high rates of evapotranspiration mean that tress can pump water and nutrients to the leaves a a great rate. Shade suppresses competition from understory plants.

In the Tropical biomes, most trees have conspicuous flowers. Flowers are conspicuous to attract insects and other animal pollinators. Many Temperate Deciduous Forest tree species have flowers with no showy petals or odors. They give no nectar, tho bees may collect their pollen. The accepted story is related to diversity. Tropical trees are very diverse, Deciduous Temperate Forest trees much, much less so. Why does this drive tropical trees to depend upon a great diversity of animal pollinators, while the Deciduous Temperate (and Boreal) Forest species generally don't bother?

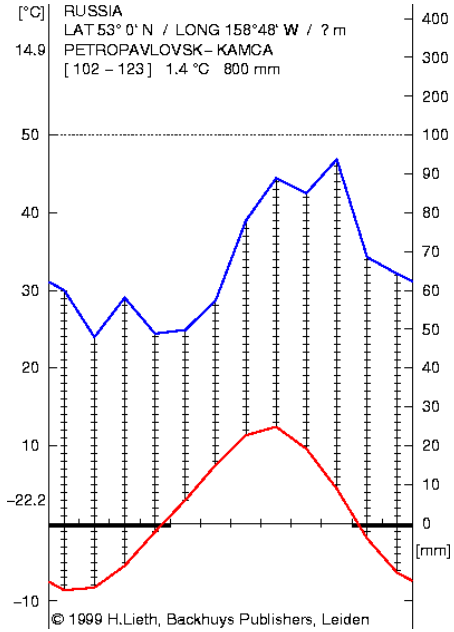
If you suffer from hay fever, you know about wind pollination! In our area, grasses, oaks, and a number of deciduous trees dump buckets of pollen into the air in the spring. Some people develop allergies to the harmless proteins on pollen surfaces. Such diseases are a very recent phenomenon. Why? A clue is that kids who grow up in dirty environments seldom suffer from allergies. A couple of dogs in the house when you are about 18 months helps a lot. You are also getting your immunizations about this same time.

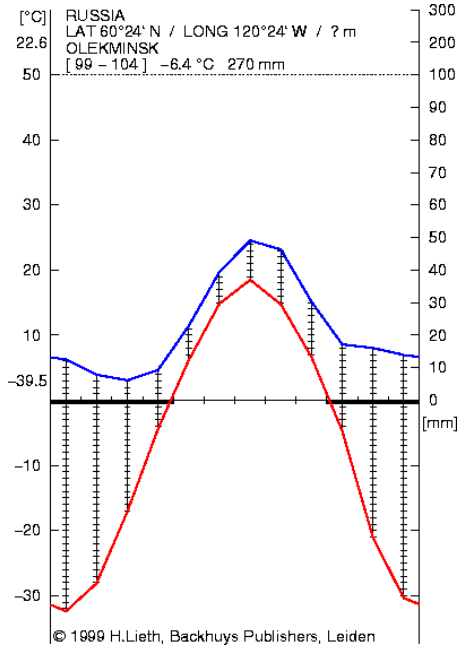


Deciduous forest canopy in summer. Syracuse NY. Note toothy leaves!

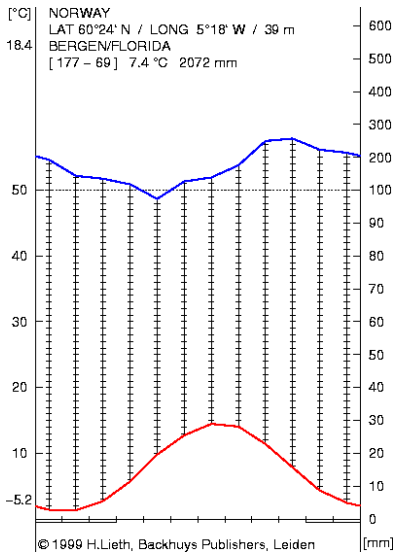
Windmill, Holland. Toothy Oak leaves in upper right corner

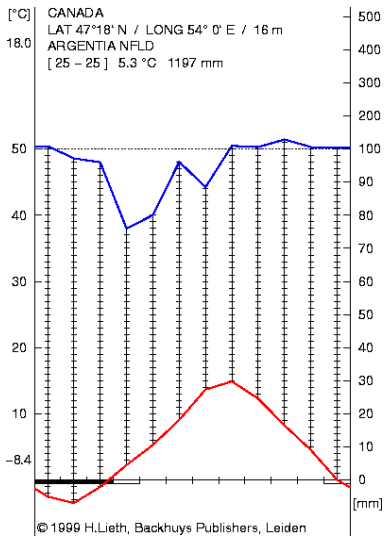
Climographs for Boreal Forest stations. Winters are long but the climates have at least 75 days of temperatures above 10 C. The Petropavlovsk climograph (Kamchatka Peninsula) is mapped as Tundra, not Boreal Forest. Although not cold in winter compared to several of the other climographs on this page, the days above 10 C fewer than 75. Since the trees are cold/drought adapted and dormant in winter, winter cold is less important that summer warmth. Thus, Bergen Norway has rather mild winters but a fairly typical Boreal Forest summer too short for deciduous trees to dominate but long enough for evergreen conifers

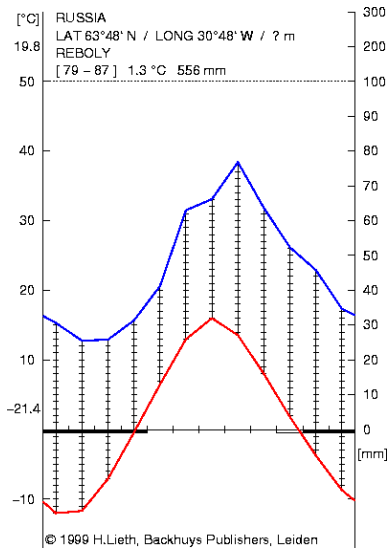


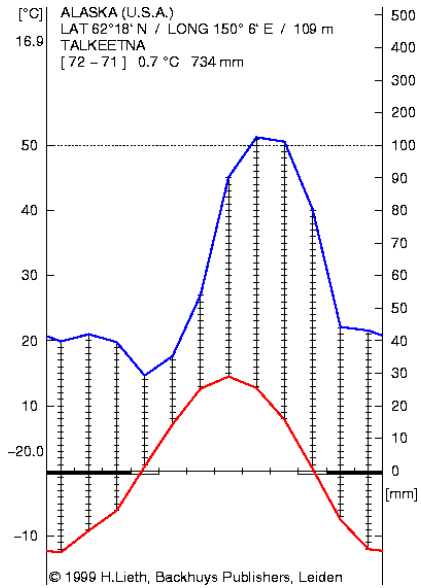


Tundra station for contrast

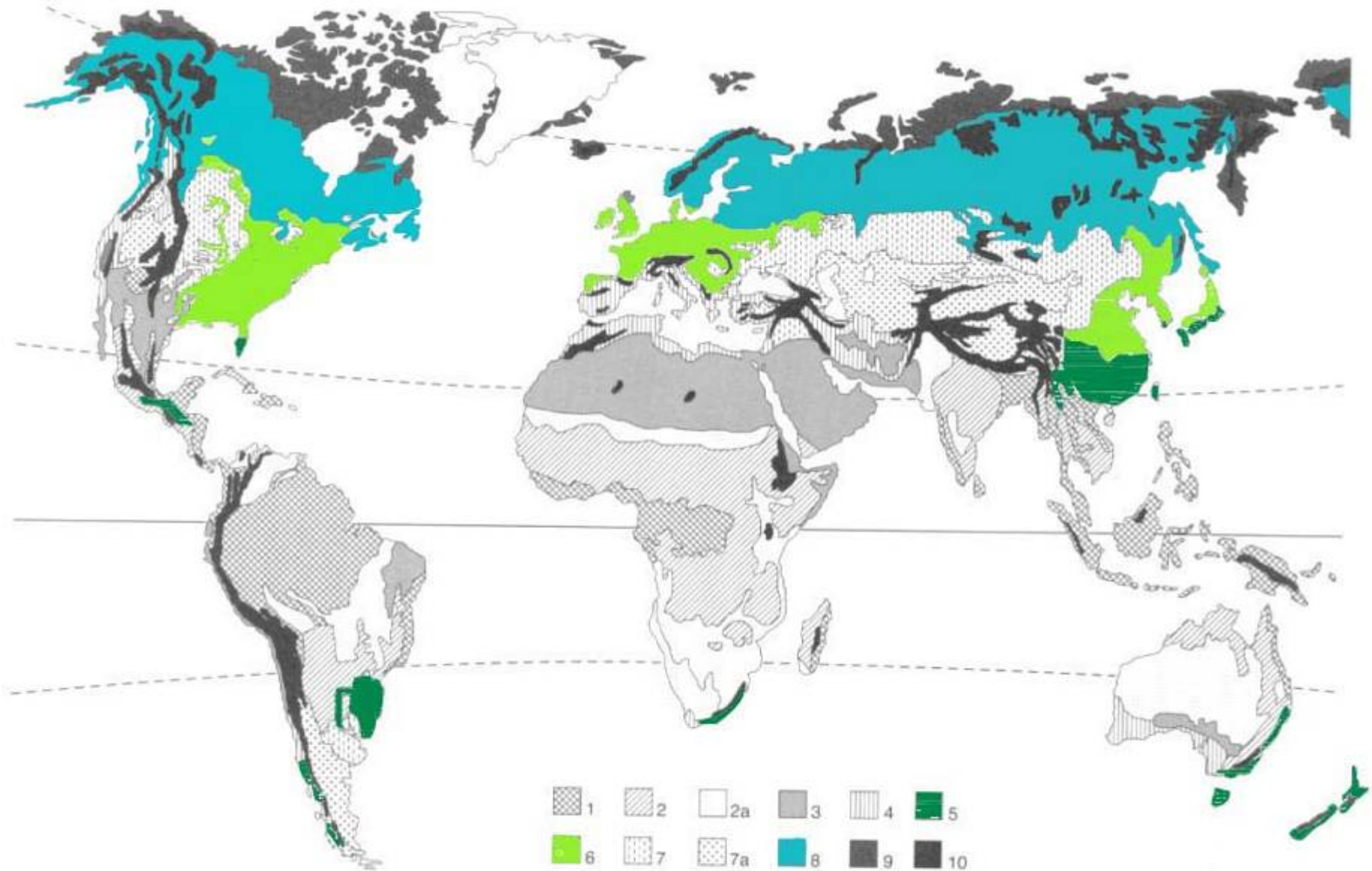




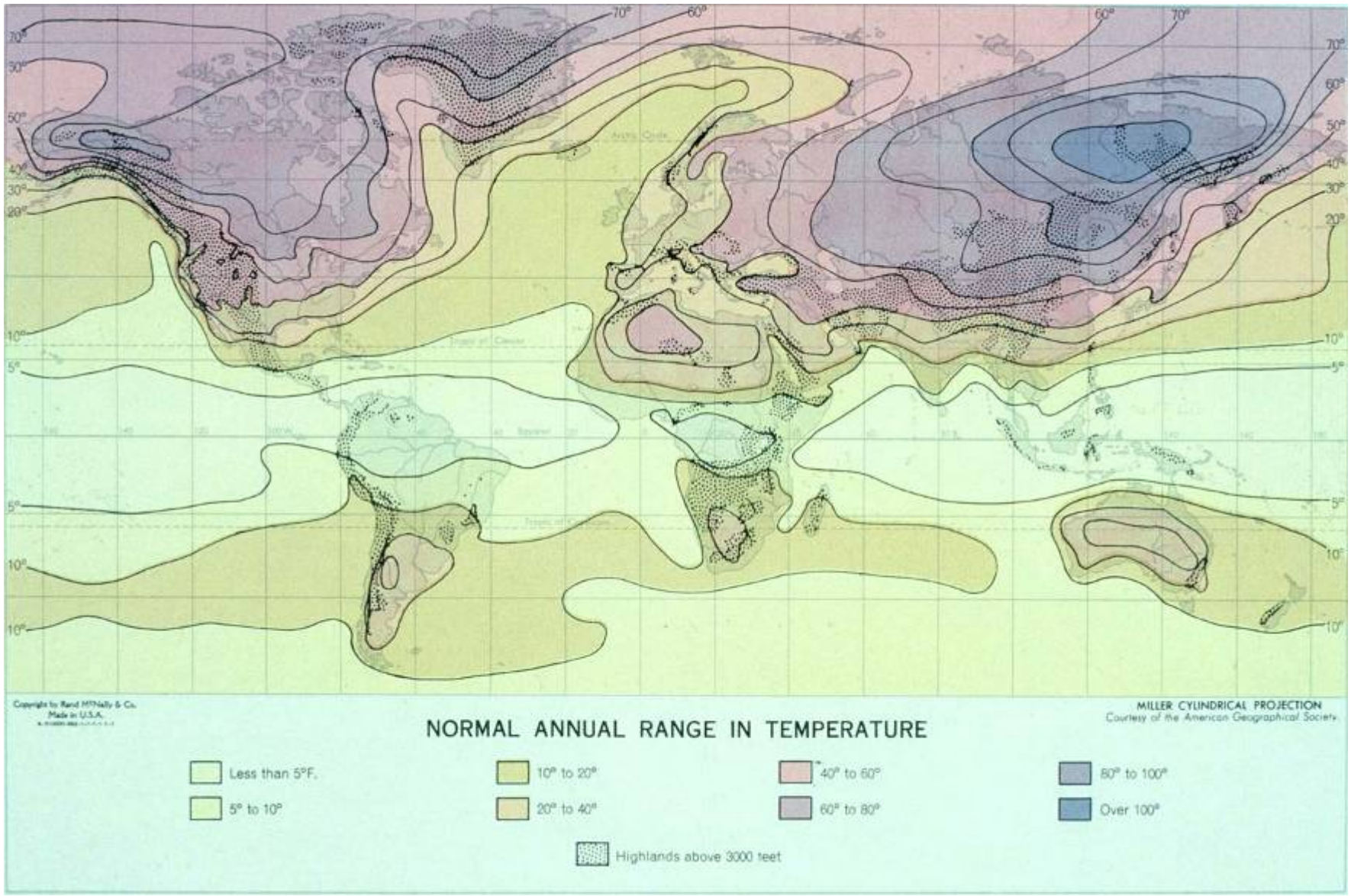




Distribution of the Temperate (5,6), and Boreal Forest (8) Biomes.

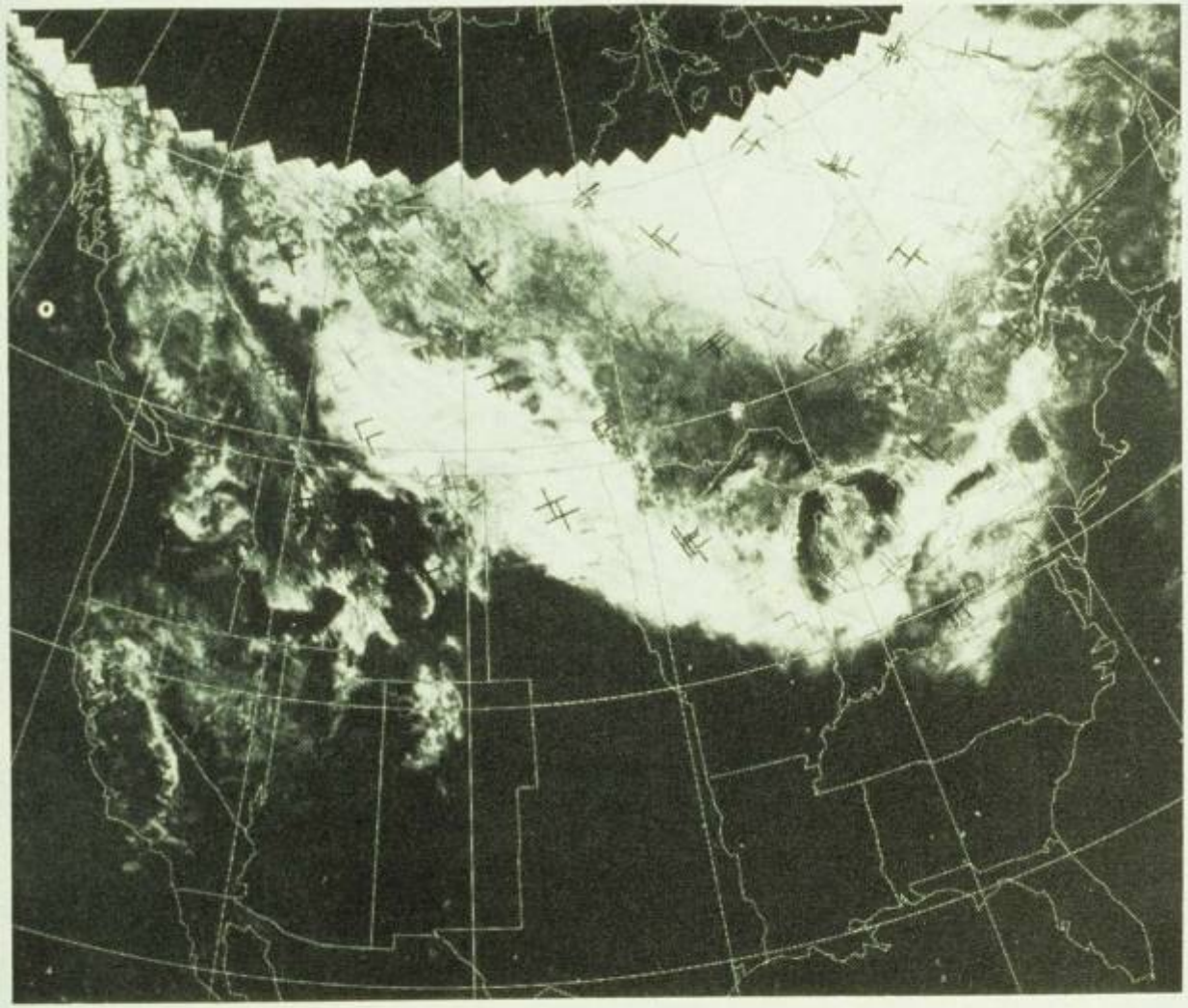


Seasonal range of temperature. Note huge ranges in highly continental eastern Siberia



Boreal Forest. Alaska. Relatively high rainfall and cool temperatures make for a rather wet environment. Lakes are also abundant. The standard conical conifer shape is adapted to shed snow. As the snow builds up on the limbs, the limbs bend down to drop it off. Standard trees with a ramifying branching pattern are highly susceptible to having limbs broken by heavy sow or ice storms. Conifers, like our foothill Gray Pine, that are little subject to snow loads do have ramifying branches.

The Boreal Forest belt in Canada and Maine shows up as dark wedge between the bright snow and ice in the Tundra to the north and the snow in the Deciduous forest and Steppe to the south and west. The snow fell in the Boreal forest but the confer limbs dropped it to the ground and remain dark above it.



FEB. 9—13, 1970: A 5-day composite minimum brightness chart produced by ESSA showed snow cover on North America. Dark bands across Canada were forested areas, where snow cover was partly masked by conifer branches.

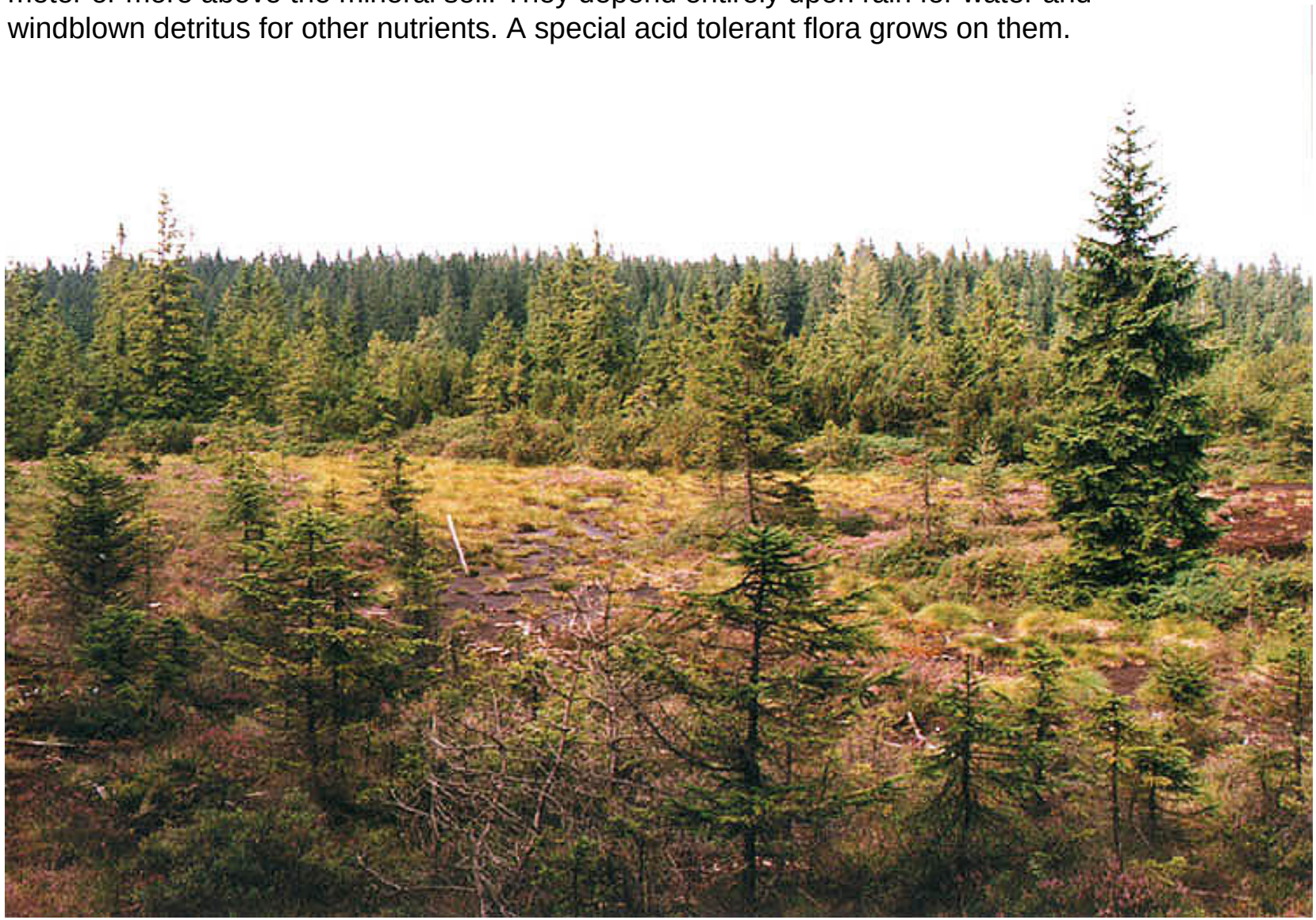
Alaska. Thin conifers on the poorly drained flat, better forest on the better drained hill in the background. Note deciduous shrub layer in foreground and some Poplars or Birch amid the conifers in the background.

Wind River Mountains, Wyoming. Glaciated surfaces like this have a lot of small-scale relief due to glacial scour and to fracturing and faulting due to rebound after glaciers melt

Mt Katahdin, Maine. Just over 5,000 feet. Note treeline at about 4,000 feet.

Understory in shady interior of Boreal Forest often poorly developed. In detail below see lichens, moss and white stems of a parasitic seed plant.

Peat Bog. Under the right conditions, Spagnum Moss can build up thick blankets of peat, the compressed, undecayed remains of the moss. Some of these are raised bogs that stand a meter or more above the mineral soil. They depend entirely upon rain for water and windblown detritus for other nutrients. A special acid tolerant flora grows on them.



Large areas of highly continental eastern Siberia have a Boreal Forest dominated by Larch, a deciduous conifer. These are the places with very severe winters but fairly long warm summers. Apparently, the needles of evergreen conifers tend to desiccate or freeze in winter here and summers are long enough and warm enough to support growing a new suit of leaves every spring.

Some signature animals of the Boreal Forest. As is often the case where plants grow slowly, they invest in physical or chemical defenses. Conifer needles are not edible by any large browser. Moose find their forage in grassy places and wade in ponds to eat pondweeds. Beaver require aspen, willow, birch and other broad-leaved trees that are less heavily defended chemically than conifers. Secondary production in relation to primary production is modest.

Wolf, Elk in background

Grizzly (Brown) Bear

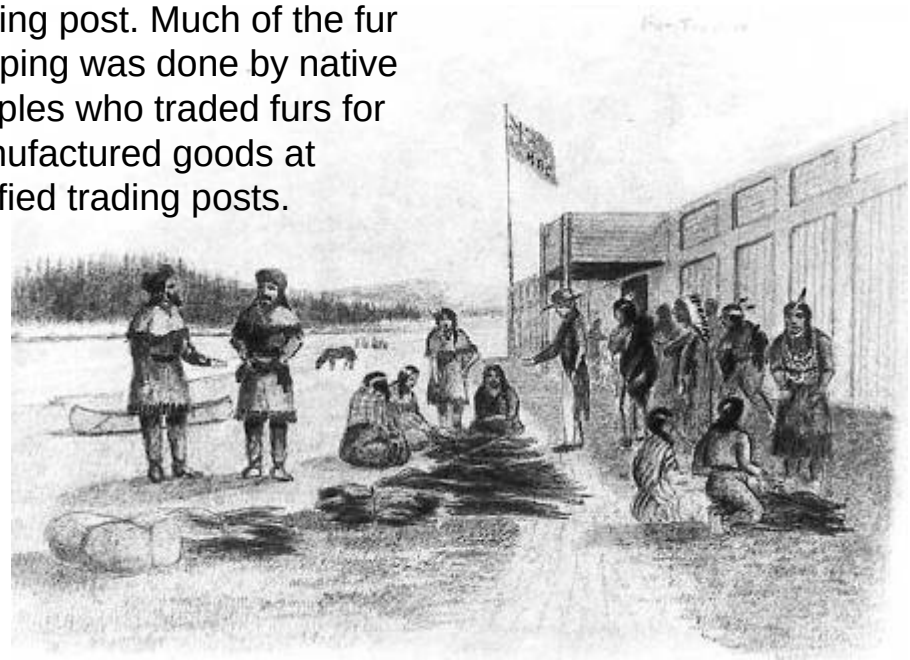
Moose, main Boreal Forest large herbivore

Beaver

Human Uses of Temperate and Boreal forests. Wood products are naturally one of the most important human uses of forests. “Softwoods” (conifers) generate wood for house construction and paper pulp. “Hardwoods” (deciduous trees) are used for furniture and cabinetry. Some hardwoods are actually softwooded (Poplars) and go for paper pulp.

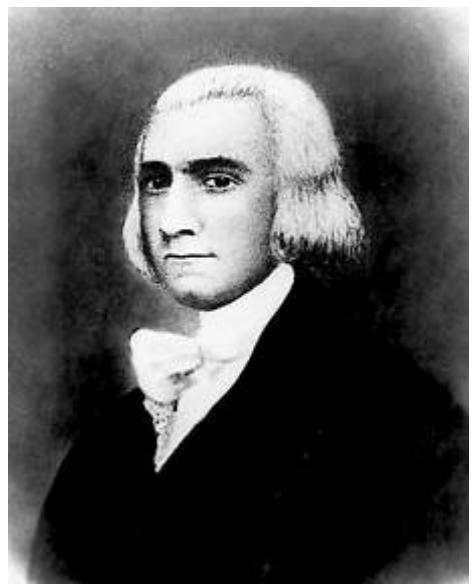
Fur industry. In the 18th and 19th Centuries, the most valuable products of the cold forests and mountains were animal pelts for clothing and beaver for hats. The Russians pioneered in Siberia, The British in northern and Western Canada, and the Americans in the Rockies, Cascades, and Sierras in pursuit of furs. The animals had the most luxurious pelts in the dead of winter in the coldest climates. Fur trappers and traders pushed far past the frontier of agricultural settlement.

Hudson's Bay Company trading post. Much of the fur trapping was done by native peoples who traded furs for manufactured goods at fortified trading posts.



Modern Chippewa trappers at work in Canada.

John Jacob Astor. Made a modest fortune in the fur trade and plowed the money into New York City real estate as that city began to boom in the early 19th Century. The Bill Gates of his day, he became America's richest man.



Upland forests are often cleared for grazing.

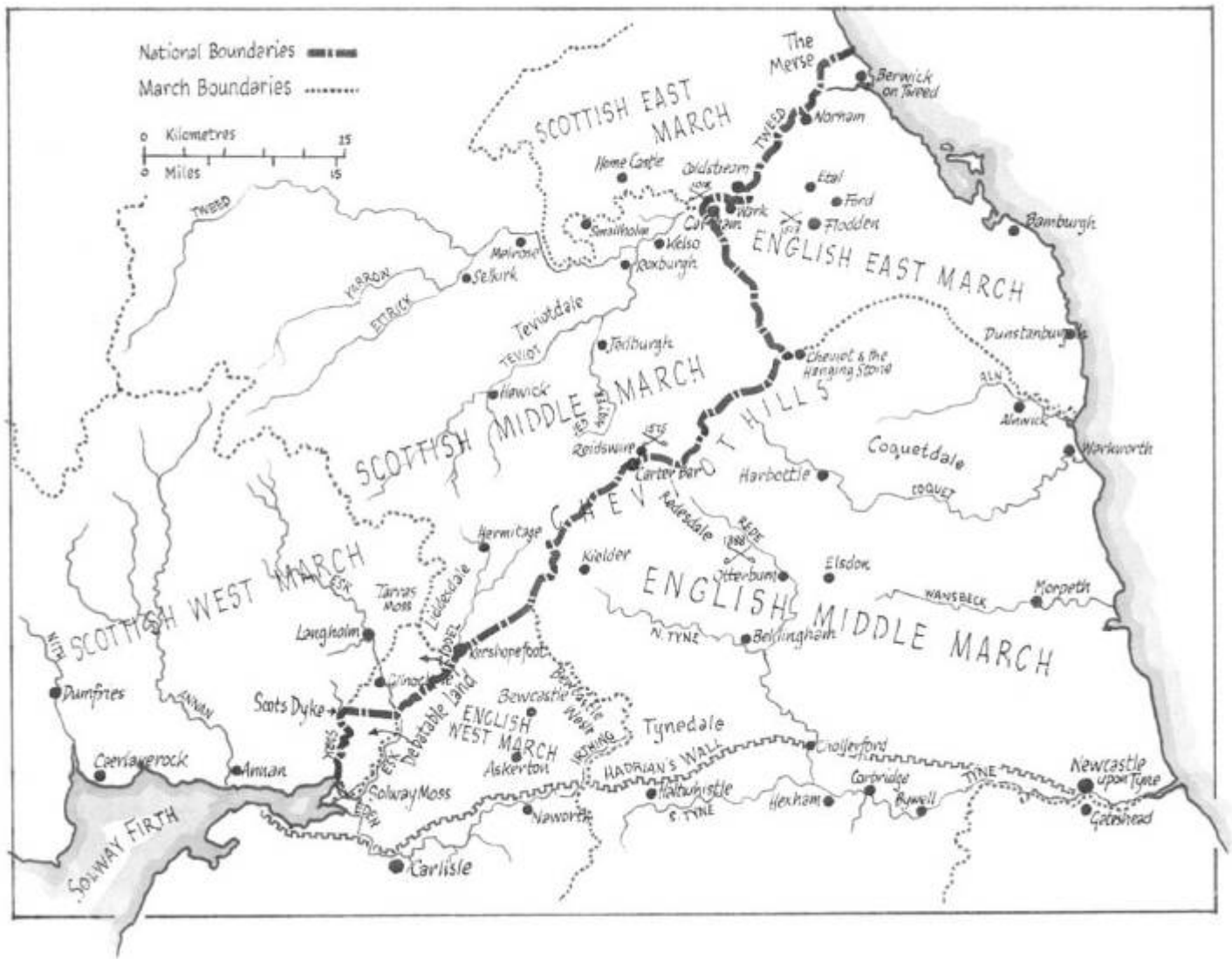
Sheep grazing on cleared Temperate Deciduous Forest.
Lake District of NW England.

Fortified “bastle” house in NE England. The borderland between England and Scotland was inhabited by rough pastoral people who raided and fought with each other until the 18th Century, when many of them came to America to become our Scots-Irish Southerners.

New Zealand Temperate Evergreen Forest recently cleared for sheep grazing

Homeland of the Scots-Irish. Areas only suitable for livestock raising typically are too unproductive to support an advanced state. Inter-state boundaries or the boundary between states and tribal areas often go through uplands, grasslands or deserts where pastoralists ply their trade. In the short run, boundaries thru poor country make sense. Borderlands are often quite turbulent and lawless as a consequence. But the Culture of lawlessness can spread.

Map of the Border country, 16th–17th centuries.

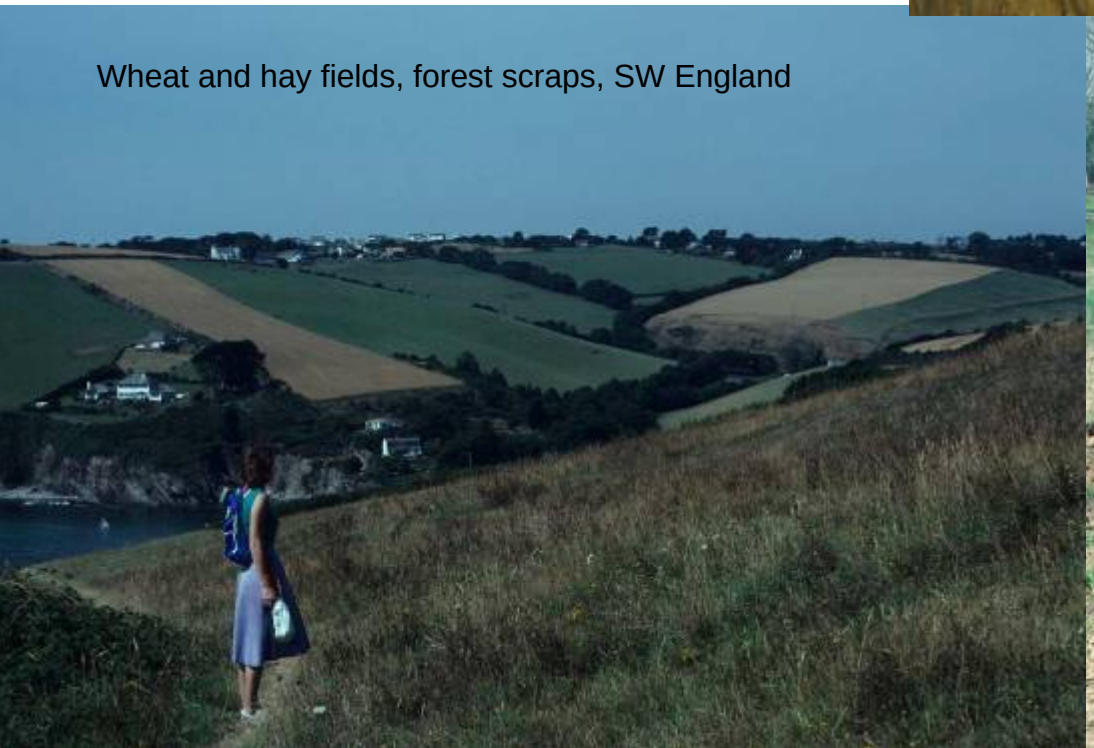


Borderland raid. “Reivers” shamelessly used the border as cover to dart across and steal livestock. Or thieves on the one side steal and pretend to be from the other. The rule of law collapsed along the English-Scotish frontier for centuries

The Irish part of Scots-Irish arose because borderland reiving was excellent military training. The English enlisted reivers in light horse cavalry units in their war of conquest in Ireland. In America, Scots-Irish warriors like Andrew Jackson used the same talents to drive the Native Americans out of the Southeastern States. Today, the Scots-Irish are the core of the Republican Party. George Bush's Texas political instincts were ultimately honed here!

Lowland forests are often cleared for agriculture in Biomes 5 and 6. In eastern North America, forests were cleared for agriculture from Maine to Georgia in the 17th and 18th Centuries. Most of this land was then abandoned in the 19th and 20th Centuries as the center of farming gravity moved to the lovely soils of Midwest. Nothing analogous happened in W Europe. Is it different soils or the more complex politics of Europe? The Slavic countries did seek German peasants to pioneer the E European Steppe and plenty of other Europeans left for the American frontiers. But European farms are pretty much where they have been since the Middle Ages.

Wheat field and forest, France, near Paris



Wheat and hay fields, forest scraps, SW England

Farm museum with 19th Century technology. North Carolina. Serious farming disappeared here in the 1920s