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Floristic zones and aeroallergen diversity

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The distribution of individual species of plants is dependent on a multitude of factors. Foremost are the conditions that constitute what is known as climate: average high and low temperatures, ambient humidity, and average precipitation. The interplay of soil factors, such as mineral content, pH, and density, also impact plant adaptation and selection. Certain plants are cosmopolitan and can adapt to a variety of circumstances, whereas other plants are found in limited niches, having adapted to extremes of temperature or moisture. The range of a native indigenous species is limited by its niche selectivity. The extent to which an introduced plant has spread is determined by its adaptability, its aggressiveness, and the length of time from the point of introduction.

The two major tumbleweeds found in the Great Plains, burning bush (*Kochia scoparia*) and Russian thistle (*Salsola kali*), were imported with grain from Russia in the late 1800s. Russian thistle was introduced into Bon Homme County, South Dakota, in 1886, as a contaminant in flaxseed. Following initial slow expansion with acclimation, it has spread widely over the entire Great Plains and throughout the western United States and Canada [1]. *Kochia*, also known as summer cypress, has been used as an ornamental plant and escaped cultivation through this route [2]. During the intervening century, this plant expanded throughout the central United States, to the Gulf coast, and California coast. *Kochia* now is found even in the northeastern states. An opposite example is that of short and giant ragweed, *Ambrosia artemisiifolia* and *Ambrosia trifida*, respectively, which are North American plants that were introduced to Europe. Short ragweed first was found in Bohemia in the 1880s, followed by more recent foci around Vienna and Lyon [3]. Giant ragweed first was found in southern Moravia in 1960. Climatic conditions are favorable to ragweed expansion, and the ragweed pollen load in Europe has been steadily increasing during the past

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15 years [3]. Introduced plants may become the dominant species in many locations, driving out native plants. A number of introduced plants thrive on disrupted soil, and occasionally, if a habitat is left undisturbed, plant succession occurs, and native plants may reestablish themselves.

Floristic zones

What plants may be found in different locations may be induced from several sources. A number of botanical texts contain maps of hardiness zones that have been defined by the United States Department of Agriculture (USDA) [4,5]. There are 12 climatic zones (Fig. 1) in the North American continent. These zones are based on the average annual minimum temperature, beginning with zone 0 ($<-60^{\circ}\text{F}$) in the frozen tundra of the Northwest Territories and progressing by about 10° increments to zone 11 ($>40^{\circ}\text{F}$) in the Florida Keys, small pockets along the southern California coast, and Hawaii. These isotherms generally define the northern limits of species because of the plants' inability to survive the cold of the winter. Exceptions may occur in protected sites with extraneous sources of heat. The USDA map does not take into consideration

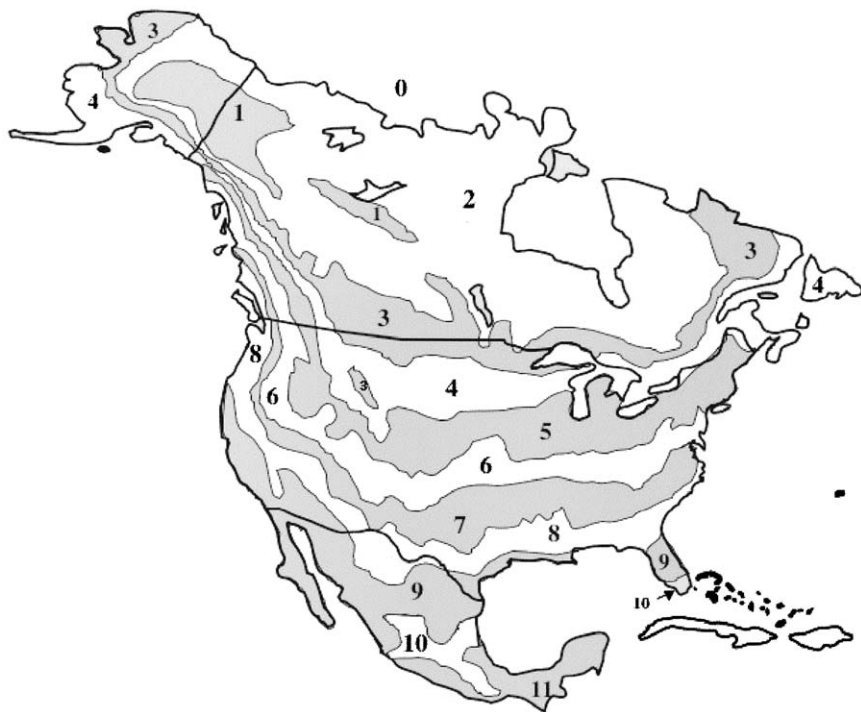


Fig. 1. Hardiness zones of North America. The zones are based on the average annual minimum temperature, which progresses by 10° increments from below -60°F in zone 0 to over 40°F in zone 11.

other factors such as rainfall or maximum temperature. A much more exact classification system has been developed for the western half of the United States [6]. Twenty-four climate zones have been described, determined by hardiness zones and the interplay of six additional factors: latitude, elevation, Pacific Ocean influence, continental air mass influence, mountains and hills, and local terrain. These zones help in defining the likely vegetation in any given region of the western states. These factors frequently impact by their effect on ambient temperature. The farther north of the equator (latitude), the longer and colder the winters are. The difference in hours of daylight between summer and winter becomes greater further from the equator and closer to the pole. Higher elevations mean colder nightly temperatures throughout the year and longer, colder winters. For each 1000 feet in elevation, the temperature drops about 3°F, or the equivalent of moving northward 600 miles [7]. Weather off of the Pacific Ocean means more year-round moisture, cooler summers with less rainfall, and milder winters. As one moves further inland from the coast, the Pacific Ocean influence becomes less, and the impact of the continental air mass becomes greater: Winters are colder, summers are hotter, and precipitation is distributed more evenly throughout the year. Because the jet stream moves air masses from west to east, individual weather patterns roll across the United States in the same direction. Mountain ranges, from the low coastal range, to the higher Sierra-Cascade ranges, to the highest Rocky Mountains, offer successively greater barriers to the Pacific Ocean effect. The areas east of the Sierra-Cascades and southern California interior mountains have significantly less rainfall than do the coastal regions. These mountains also diminish the continental air mass effect as one goes west. A mirror image of these effects can be expected in the eastern states, from an Atlantic Ocean influence, with the Appalachian chain providing an inland barrier. Because winds are westerly, however, the Atlantic Ocean impact is felt to a lesser distance inland. The lake effect from the Great Lakes has a similar, though lesser, effect than the ocean effect.

Local topology, hills or sloping plains, has the greatest impact from late fall through winter and into the early spring: the times of frosts and freezing weather. Cold air is denser and sinks, whereas warmer air rises. Cold air flows downhill like water. The lowest part of a slanting plain, such as a river valley, holds the cold air (cold-air basins), whereas the hills above have a thermal belt of warmer temperature. These conditions persist until lower temperatures attend sufficient gain in elevation.

Some botany texts divide the North American continent into fewer floristic regions [8]. In allergy literature, Solomon similarly has popularized 10 floristic zones (Fig. 2) that are a cross between the USDA hardiness zones and factors like those considered in the western system. These zones offer a useful compromise to the cumbersome 24-zone system [9,10]. Although the borders of the zones purposely are ill-defined, they are perhaps more descriptive of the territory. Using Solomon's nomenclature, the zones are: Northern Forest, Eastern Agricultural, Southeastern Coastal Plain, Florida Subtropical, Central Plains, Rocky Mountain, Arid Southwest, Great Basin, Northwest Coastal, and California Lowland. [Figure 2](#)

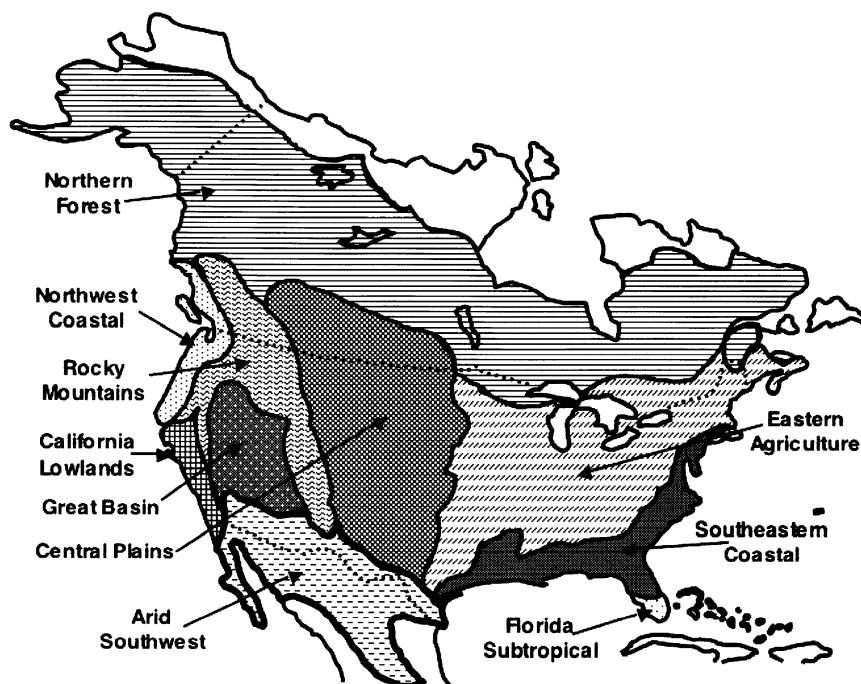


Fig. 2. Floristic zones of North America. (Data from Refs. [8–10].)

is a composite from several of these sources [6,8–10]. Characteristics of the regions and representative plant habitats are addressed later in this article and are summarized in Table 1. These tables are not meant to be inclusive, but rather serve to impart an impression of the typical flora. An additional useful reference that includes distribution maps of many native allergenic plants is *Airborne and Allergenic Pollen of North America* [11]; however, numbers of introduced major allergenic plants do not have distribution maps. An older classic text, published in 1955, *Regional Allergy of the United States, Canada, Mexico & Cuba*, still has useful information but is difficult to find [12].

Aeroallergens by region

Northern Forest zone

The Northern Forest zone touches northern portions of New England, Michigan, and Minnesota, extends through eastern Canada, and covers much of northwestern Canada and the Alaskan interior. The boreal forest is primarily coniferous and includes members of Cupressaceae, such as juniper (*Juniperus*, *Thuja*) and cedar (*Cedrus*); and Pinaceae, such as pine (*Pinus*), spruce (*Picea*), and fir (*Abies*, *Pseudotsuga*). Hardwoods are represented by the families

Table 1
Floristic zones and allergenic plants

Zone	Trees/shrubs	Grasses ^a	Weeds
Northern Forest	Coniferous: juniper (<i>Juniperus</i> , <i>Thuja</i>), cedar (<i>Cedrus</i>), pine (<i>Pinus</i>), fir (<i>Abies</i>); hardwoods: birch (<i>Betula</i>), alder (<i>Alnus</i>), aspen (<i>Populus</i>), willow (<i>Salix</i>), maple (<i>Acer</i>)	Pasture grasses (low levels)	Mugwort (<i>Artemisia</i>), nettle (<i>Urtica</i>), chenopods (<i>Chenopodium</i> , <i>Kochia</i>), pigweeds (<i>Amaranthus</i>) (all low levels)
Eastern Agricultural	Red cedar (<i>Juniperus</i>), pines, white and red oaks (<i>Quercus</i>), beech (<i>Fagus</i>), elms (<i>Ulmus</i>), ash (<i>Fraxinus</i>), sycamore (<i>Plantanus</i>), maples, box elder (<i>Acer</i>), alder, red birch, hickory (<i>Carya</i>), black walnut (<i>Juglans</i>), locust (<i>Robinia</i>), hawthorn (<i>Crategus</i>)	Pasture grasses in northeast: ryegrass (<i>Lolium</i>), orchard (<i>Dactylis</i>), fescue (<i>Festuca</i>), brome and chess (<i>Bromus</i>), timothy (<i>Phleum</i>), sweet vernal (<i>Anthoxanthum</i>); southern states: Bermuda (<i>Cynodon</i>), Johnson (<i>Sorghum</i>)	Short, giant, southern, and western ragweed (<i>Ambrosia</i>), mugwort, pigweeds, lamb's quarter (<i>Chenopodium</i>), nettle, dock and sorrel (<i>Rumex</i>), plantain (<i>Plantago</i>)
Central Plains	As in Eastern Agricultural; cottonwood (<i>Populus</i>)	As in Eastern Agricultural	As in Eastern Agricultural; Chenopods (<i>Kochia</i> , <i>Salsola</i> , <i>Atriplex</i>), pigweeds, waterhemp (<i>Ancida</i>)
Rocky Mountain	willow, box elder, locust Mountain cedar (<i>Juniperus</i>), ponderosa, lodgepole pine (<i>Pinus</i>), aspen, willow, box elder, cottonwood, gambel oak, maple, ash	Pasture grasses: ryegrass, orchard, fescue, brome and chess, timothy	Tumbleweeds (<i>Kochia</i> , <i>Salsola</i>), other chenopods and amaranths, dock (<i>Rumex</i>), giant, western ragweed, sagebrush, prairie sage (<i>Artemisia</i>)
Northwest Coastal	Cedar, fir, pine, alder, birch, hazel (<i>Corylus</i>)	Timothy, orchard, brome, ryegrass, fescue, sweet vernal, velvet grass (<i>Holcus</i>)	Plantain, short ragweed, orach (<i>Atriplex</i>), amaranths, chenopods, dock, sorrel
California Lowland	Alder (<i>Alnus</i>), olive (<i>Olea</i>), walnut (<i>Juglans</i>), sycamore (<i>Plantanus</i>), willow (<i>Salix</i>), elm (<i>Ulmus</i>) eucalyptus (<i>Eucalyptus</i>)	Pasture grasses, Bermuda (<i>Cynodon</i>), Johnson (<i>Sorghum</i>), velvet (<i>Holcus</i>)	Scales (<i>Atriplex</i>), Palmer's amaranth (<i>Amaranthus</i>), tumbleweeds (<i>Kochia</i> , <i>Salsola</i>), <i>Baccharis</i> , nettle (<i>Urtica</i>)
Arid Southwest	Mountain cedar (<i>Juniperus</i>), ash (<i>Fraxinus</i>), mulberry (<i>Morus</i>), acacia (<i>Acacia</i>), mesquite (<i>Prosopis</i>)	Pasture grasses, Bermuda, witchgrass (<i>Panicum</i>), grama (<i>Bouteloua</i>)	Scales, Palmer's amaranth, tumbleweeds

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Table 1 (continued)

Zone	Trees/shrubs	Grasses ^a	Weeds
Great Basin	As in Rocky Mountain and Arid Southwest	Pasture grasses, Bermuda, Johnson, witchgrass	Scales, tumbleweeds, rabbitbrush (<i>Chrysothamnus</i>), marshelders (<i>Iva</i>)
Southeastern Coastal	As in Eastern Agricultural; bald cypress (<i>Taxodium</i>), live oak (<i>Quercus</i>), box elder (<i>Acer</i>), elm, hackberry (<i>Celtis</i>), ash, hornbeams (<i>Carpinus</i> , <i>Ostryia</i>), hickory, pecans (<i>Carya</i>) sweet gum (<i>Liquidambar</i>)	As in Eastern Agricultural; bahia and dallis (<i>Paspalum</i>)	As in Eastern Agricultural; <i>Baccharis</i>
Subtropical Florida	Pine, bald cypress, live oak, mulberry, eucalyptus, palm (<i>Phoenix</i> , <i>Cocos</i>), palmetto (<i>Sabal</i>)	Bermuda, Johnson, bahia, dallis	Short ragweed (<i>Ambrosia</i>), sea-myrtle (<i>Baccharis</i>), spiny and redroot pigweeds (<i>Amaranthus</i>), goosefoots (<i>Chenopodium</i>)

Genus listed with first entry in table.

^a Inclusive of Alaska.

Betulaceae (birch, alder), Salicaceae (willows, aspen [*Populus tremuloides*]), and Sapindaceae (maples). The range of aspen is from Labrador and Hudson Bay to Alaska, southward throughout Canada, and most of the United States. Alders are prevalent along the northern tier, from the Pacific Northwest up into Alaska, across the Northern Forest to the Maritime Provinces, extending southerly along the Rocky Mountain range. Alder and birch are major spring aeroallergen sources in Scandinavia. As is seen in Scandinavia, the major aeroallergens are neither grasses nor weeds, but rather trees. Northern pasture grasses, subfamily Festucoideae (or Pooideae), are represented by members such as timothy (*Phleum pratense*), red fescue (*Festuca rubra*), and June (*Poa pratensis*), but are a minor allergen burden compared with trees. Similarly, weeds are also less important, but sages (*Artemisia*), nettle (*Urtica*), fireweed (*Epilobium angustifolium*), dock (*Rumex*), and Chenopod-Amaranth weeds are found.

Eastern Agricultural zone

The expansive region of the Eastern Agricultural zone was primarily deciduous forest and was replaced extensively by urbanization and farming activity. This floristic zone is still characterized by a marked diversity of trees, grasses, and weeds. The zone brackets southern portions of Ontario and Quebec, moves south into eastern Texas, and crosses the Mississippi River valley to the Central Plains. Common conifers are eastern red cedar (*Juniperus virginiana*) in the south and central states, white cedar (*Thuja occidentalis*), and white pine (*Pinus*

strobis) in the northeast. Deciduous trees are represented by beeches (*Fagus*), oaks (*Quercus*), elms and hackberries, maples and box elder, ashes, alders, hazels, birches, hornbeams American elm, willows and poplars, sycamores, mulberries, walnuts, pecans, and hickories. *Ulmus americana* has had a wide range, from the entire eastern states through the Central Plains. During the past 60 years, however, it has been decimated by Dutch elm disease. Siberian elm (*Ulmus pumila*), after its introduction in the 1860s, is common has a range similar to that of *Ulmus americana* [13]. White and red oaks (*Quercus*) are abundant hardy trees that prefer drier soils from the southern edges of the Northern forest to the tropics. They frequently are found mixed with pines. Maples (*Acer*) and box elder (*Acer negundo*) are prominent in this zone and extend into the Central Plains. The maples are most prevalent east of the Great Plains, and certain others are found in the Pacific Northwest and Rocky Mountains. The distribution of silver maple (*Acer saccharinum*) is from Minnesota, across Ontario, to New Brunswick and Maine, bracketing the Great Lakes and the Saint Lawrence Seaway; east along the Appalachians; west to the Mississippi River Valley; and south almost to the Gulf. Members of the walnut family Juglandaceae, such as walnut, pecan, and hickory, generally are limited to this floristic zone and the Southeastern Coastal, except where cultivated. Honey locust (*Gleditsia triacanthos*) and black locust (*Robinia pseudoacacia*) are native to the mideastern United States. In Canada, honey locust is limited to southwestern Ontario, but black locust, being a cold hardy plant, has been introduced across southern Canada.

Northern pasture grasses are found in great abundance and diversity throughout this floristic zone: They have been cultivated for hay and seed crops, grown in lawns, and escaped from horticulture. The following grasses are especially common in the northeast: ryegrass (*Lolium*), orchard (*Dactylis*), fescue (*Festuca*), brome and chess (*Bromus*), timothy (*Phleum*), and sweet vernal (*Anthoxanthum*). In the southern states, Bermuda (*Cynodon*) and Johnson (*Sorghum*) grasses are more common.

Weeds are amply represented by several *Ambrosia* ragweeds: short, giant, southern, and western ragweeds. The most prevalent sage is common mugwort (*Artemisia vulgaris*). Other ubiquitous weeds include the pigweeds (*Amaranthus*), lamb's quarter (*Chenopodium*), nettle (*Urtica*), docks and sorrels (*Rumex*), and English and common plantains (*Plantago*).

Central Plains zone

The Central Plains zone comprises the midsection of the United States, beginning in the rolling hills west of the Mississippi drainage and rising and flattening out as it progresses westward toward the Rocky Mountains. Soils range from sandy to clay loam, with a pH that is slightly acidic to neutral to basic. Gypsum beds and saltbeds occur [14]. In the Great Plains, eastern cottonwood (*Populus deltoides*) is common, especially along river and creek beds. As the grasslands extend northerly into Canada, *Populus deltoides* gives way to aspen, black cottonwood (*Populus trichocarpa*), and balsam poplar (*Populus balsami-*

fera). Mesquite (*Prosopis*) is common in the Texas rolling plains, along with hackberry (*Celtis*), junipers, and mountain cedars (*Juniperus*).

In areas not dedicated to cultivation but used as pasture or grazing land, short- and medium-height grasses have replaced tall-grass prairies; this change is common west of the 100th meridian (Texas and Oklahoma panhandles). Johnson grass, although found as far north as Wyoming and New York, is predominantly a southern grass and is common in tropical and warmer regions of both hemispheres [15].

As commented earlier, the Chenopod-Amaranth tumbleweeds are well established throughout the Great Plains and are significant inducers of late-summer hayfever. In the more humid southeastern portions, western waterhemp (*Amaranthus* [*Acnida*] *tamariscinus*) is found. In the eastern regions, short and giant ragweeds are prevalent, and further west, short ragweed is supplanted by western ragweed. The highest counts of ragweed pollen in the United States have been found in the Omaha area of the Midwest. Prairie sages such as *Artemisia ludoviciana* are more common than mugwort.

Rocky Mountain zone

The floristic pattern of the Rocky Mountains is complex because of the diversity of its topography and resultant climate. Plant community niches are dependent in a large degree to altitude, but great overlap is seen, with one type present on a south slope and another type facing across a valley on a north slope [16]. East of the Rocky Mountains, the Central Plains rise up to elevations approaching 5900 feet. Foothills rise from this elevation to 8200 feet. Gambel oak (*Quercus gambelii*) and shrubby mountain-mahogany (*Cercocarpus*) are common at lower elevations, with ponderosa pine higher and grasslands mixed in. Douglas fir is found in northern exposed ravines, and deciduous trees and shrubs are found along creek beds. Montane represents a transitional zone between foothills and subalpine flora, from about 8200 to 8850 feet. Trees in this zone include ponderosa and lodgepole pines, Douglas fir, aspen, and Englemann and blue spruces. Subalpine vegetation is found from this level up to 11,150 feet, with firs, spruces, and pines interspersed with bogs, ponds, and moist meadows ripe with wildflowers. The alpine tundra rises further to above 13,100 feet; above timberline, with grasses, sedges, and dwarf willows. Quaking aspen (*Populus tremuloides*) is perhaps the most widely recognized of western trees. It is a characteristic constituent of the Rocky Mountains flora, ranging from the foothills to the montane and subalpine regions. Westward of the Rockies, the terrain assumes the more arid aspect of the Great Basin and Arid Southwest.

Historically, mountainous areas have been visited as pollen havens, with the observation that pollen counts diminish with increasing elevation [17–19]. This finding has been reinforced in some texts [20,21]. A report from a subalpine station in Gothic, Colorado (elevation, 9200 feet), supported this contention, although paradoxically the grass pollen counts in that report were higher than those commonly seen in Denver [22,23]. Lower pollen counts at high elevations have been attributed to a number of factors: less luxuriant growth because of cold

temperatures, the interplay of temperature inversions and katabatic winds, and semiarid conditions [17,23,24]. Davies previously had suggested that the prevalence of a grass species that produces scant amounts of pollen was partially responsible for lower grass pollen counts noted at Davos, Switzerland [18]. Silvers et al showed that other factors besides altitude are important and that appreciable pollen may be encountered despite high elevation. An assortment of tree pollens was found, occasionally in high numbers, at two mountain locations, Aspen and Vail [23]. The theory that elevation itself is not a bar for high pollen production is supported by the high grass pollen counts reported by Buck and Levetin at Gothic [22]. Climatic conditions, such as snowfall, snow pack, rain, temperature, and the timing of these factors, seem to have a large impact on pollen production at higher elevations.

Northwest Coastal zone

The Northwest Coastal zone stretches from the northernmost California coastline, up through Oregon and Washington, and along the British Columbia coast. Its eastern boundary is the Cascades and the Coast Mountains in Canada. The Cascades act as an effective rain barrier, so that the eastern portions of Oregon and Washington are much drier than the western portions. In turn, the zone is divided by the lower Coast Range and Olympics into a coastal strip and a valley area [25]. The Pacific Ocean effect makes for a mild, humid, uniform climate. Annual rainfall in the coastal area is about 75 inches, up to 130 inches in the higher elevations of the Coastal Range, and between 18 to 50 inches in the valley region. The average monthly temperatures span from about 40°F to 65°F. Northern pasture grasses account for the greatest aeroallergen burden, especially from April to August; followed by the most prevalent tree pollen, alder, pollinating from February through April. A mix of other trees (eg, cedar, elm, birch, maple, willow, hazel) is included. Plantains may account for a quarter of the airborne pollen in July and August. Pollination may be prolonged, from May through October. Sheep sorrel is common earlier, in April and May. Other weeds include lamb's quarter, redroot pigweed, orach (*Atriplex*), and short ragweed. Fern spores are common but of uncertain aeroallergenic importance.

California Lowland zone

The California Lowland zone incorporates the California coastline as far north as the Bay area, and much of the interior valleys. It is more heterogeneous than many of the other floristic zones described in this article. It incorporates the small pockets of southern coastline that are hardiness zone 11 (subtropical) and a strip of zone 10 that extends midway up the coast. Interior valleys that have a predominant marine effect have a milder climate, whereas portions of the central valley that are shielded by a higher Coastal Range may experience greater extremes of temperature than that seen along the coast [6,26,27]. Trees include cedar and juniper, alder, olive, walnut, sycamore, willow, elm, and eucalyptus (*Eucalyptus*). Prevalent

grasses include Bermuda, Johnson, brome, canary (*Phalaris*), redtop (*Agrostis*) and ryegrass. Common weeds are pigweed, scales, lamb's quarter, smotherweed (*Bassia*), sage, and false ragweed. Pellitory (*Parietaria*) is found in limited distribution throughout the United States, but may be a problem in the California bay area. Along the coast, some species of *Baccharis* are wind-pollinated and have been incriminated as hayfever producers.

Arid Southwest zone

There are four desert regions in the southwestern United States [28]. The Chihuahuan Desert is primarily in northern Mexico (its name is derived from that area), but extends up into western Texas and across into southern New Mexico and southeastern Arizona. The Sonoran Desert runs across south central and southwestern Arizona into southern California, and south into mainland Mexico and Baja California, bracketing the Gulf of California. The Mojave Desert, the smallest region, is contiguous with the Sonoran Desert to the south and the Great Basin Desert to the north.

The Chihuahuan Desert lies at higher elevations compared with the other deserts: 2000 to 5000 feet in the north and 5000 to 6000 feet in the south. Winter temperatures are low, and freezes occasionally persist for several days. Precipitation comes as localized summer thunderstorms. Runoff is frequently into basins and not into rivers. Common vegetation includes *Acacia*, tarbush, creosote bush, and guayule (*Parthenium argentatum*).

The Sonoran Desert ranges in elevation from below sea level to 4500 feet. It is the warmest of the four deserts, rarely has persistent freezing temperatures, and has highs frequently at greater than or equal to 120°F in the west. There are winter and summer rainy seasons, but the annual precipitation may vary from greater than 2 to 12 inches, dependent on elevation [28]. Characteristic plants are saguaro cactus, paloverde (*Cercidium*), bursage (*Ambrosia*), ironwood, cholla, and creosote bush.

The Mojave Desert lies between 280 feet below sea level to about 4000 feet. Annual rainfall is 3 to 4 inches at the desert floor to 11 inches at higher elevations. Rainfall primarily occurs in the fall and winter. Temperatures reach the highest recorded in the United States (134°F); however, the winters are colder than those in the Sonoran Desert. Typical vegetation includes Joshua tree (*Yucca brevifolia*), bursage, creosote bush, and indigo bush.

Mesquite (*Prosopis*) is distributed widely across the southwest at elevations of 2000 to 4000 feet, along streambeds and areas holding moisture. Ashes (*Fraxinus*), depending on the species grow at elevations from 2000 to 7000 feet. Rising from the deserts, from 4500 to 6500 feet, is the pinyon-juniper belt, where scrub junipers and pinyon pine cover foothills and lower mountains [8]. In central and western Texas, mountain cedar (*Juniperus ashei*) counts may be greater than 10,000 grains/m³, and this plant is the leading cause of pollinosis. Shadscale, saltbush, and greasewood weeds are interspersed, especially where the soil is more alkaline. Giant sagebrush (*Artemisia tridentate*) may extend over large expanses with no trees seen.

Species such as white mulberry (*Morus alba*), which were introduced into the larger cities of Arizona, have become such a hayfever nuisance that law prohibits further plantings. Ashes are troublesome in the southwest. European olive, (*Olea europaea*), where it has been cultivated commercially, has become a significant aeroallergen. Palmer's amaranth (*Amaranthus palmeri*) is common in the southwest. Grasses are the typical southern species, such as Bermuda or witchgrass (*Panicum capillare*).

Great Basin zone

The Great Basin Desert is only slightly smaller than the Chihuahuan Desert, encompassing nearly 190,000 square miles. It covers most of Nevada and Utah, extending into parts of Wyoming, Idaho, Oregon, and Washington. Lying east of the Sierra Nevada-Cascade chain, the Basin receives between 4 to 12 inches of precipitation annually, equally divided between winter and summer. [28] This cold desert has freezing temperatures and snow always in the winter. Its trees are those that are found as in the Rocky Mountain and Arid Southwest zones, and similarly, pasture grasses, plus Bermuda grass, Johnson grass, and witchgrass. Common shrubs and weeds are giant sagebrush, *Atriplex* scales and saltbushes, greasewood (*Sarcobatus vermiculatus*), winter fat (*Eurotia lanatus*), and rabbit-brush (*Chrysothamnus nauseosus*).

Southeastern Coastal Plain zone

The Southeastern Coastal Plain zone is bounded by the Appalachian chain, wrapping along the eastern seaboard from the Virginia Tidewaters, across northern and central Florida, and along the Gulf Coast into Texas. It extends inland northward along the lower Mississippi drainage. On the Eastern Seaboard, the zone runs inland throughout wetlands to the Appalachian piedmont. Prevalent trees are the same as those that are found in the Eastern Agricultural zone: numerous oaks, maples and box elder, elms, hackberry (*Celtis*), ash, hornbeams (*Carpinus*, *Ostryia*), hickory, pecan (*Carya*), and sweet gum (*Liquidambar*). Bald cypress (*Taxodium distichum*) and live oak (*Quercus virginiana*) also are found. Except in the most northern reaches, the dominant grass is Bermuda grass. Pasture grasses are the same as those found in the Eastern Agricultural zone, and, more typically, southern grasses such as Johnson, Sudan (*Sorghum sudanensis*), bahia and dallis grasses (*Paspalum*) are also prevalent. Prevalent weeds are the same as those found in the Eastern Agricultural zone: sheep sorrel (*Rumex acetosella*), plantains (*Plantago*), *Baccharis*, Chenopod-Amaranth weeds such as burning bush, pigweeds, western waterhemp, marshelders (*Iva*), and short, giant, and southern ragweeds.

Florida Subtropical zone

The southern half of Florida is in hardiness zone 10 (subtropical), with the tip and the Keys in zone 11 (tropical). Generally, because of the strong maritime

effect over the entire state, fluctuations in temperature are modest. In part because of the greater humidity, pollen counts are lower than those in other zones, although pollen anthesis is extended greatly. Grasses such as Bermuda, Johnson, bahia, and dallis essentially pollinate all year, and short ragweed pollinates from March through November [11]. Trees include pine, bald cypress, live oak, mulberry, eucalyptus, Australian pine (*Casuarina*), palms (*Phoenix*, *Cocos*), and palmetto (*Sabal*). The allergenic role of palm pollen is being looked at again in southern California and Florida. Common weeds are short ragweed, sea-myrtle (*Baccharis*), spiny and redroot pigweeds, and goosefoots (*Chenopodium*).

Summary

The interplay of geographic, geochemical, and meteorologic factors combines to define distinct floristic zones in North America. Latitude, elevation, Pacific or Atlantic Ocean influence, continental air mass influence, mountains, and hills are contributory geographic factors. Hardiness zones are defined by the nadir of temperature, which strongly affects the survival of individual plant species. There are 12 hardiness zones from the northernmost tundra to the tropics of Mexico. Although it is useful to consider the 10 major floristic zones, the hardiness zones cut across these zones and characterize subregions. A multiplicity of local terrain effects, such as soil porosity and acidity, and sun exposure also impact on plant growth.

The ability of plant species, whether woody shrubs and trees, or herbaceous weeds and grasses, to adapt to conditions within the floristic zones determines their range. This article identifies the major aeroallergenic species and the regions in which they are most prevalent.

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