

THE DISTRIBUTION OF THE NORTH AMERICAN
FLORA.BY SIR JOSEPH DALTON HOOKER.¹

WHATEVER countries beyond the seas we may visit, in the temperate regions of the globe, we find that their vegetation has been invaded, and in many cases profoundly modified by immigrant plants from other countries, and these are in almost all cases natives of North-western Europe. Nearly forty years ago I arrived at night at the Falkland islands, when a boat was sent ashore to communicate the ship's arrival to the Governor; and, being eager to know something of the vegetation of the islands, I asked the officer in charge of the boat to pluck for me any plants he could feel for, as it was too dark to see anything, and the armful he brought to me consisted of nothing but the English shepherd's purse. On another occasion, landing on a small uninhabited island,² nearly at the Antipodes, the first evidence I met with of its having been previously visited by man, was the English chickweed; and this I traced to a mound that marked the grave of a British sailor, and that was covered with the plant, doubtless the offspring of seed that had adhered to the spade or mattock with which the grave had been dug.

It was hence no surprise to me to find myself, on landing at Boston last summer, greeted by Western European plants that had established themselves as colonists in New England. Of these the first was the wild chicory, growing far more luxuriantly than I ever saw it do elsewhere, forming a tangled mass of stems and branches, studded with turquoise-blue blossoms, and covering acres of ground; the very next plants that attracted my attention were the oxeye-daisy and Mayweed, which together whitened the banks in some places, and which I subsequently tracked more than half way across the continent.

These, and more than two hundred and fifty other Old England plants, which are now peopling New England, were for the most part fellow-emigrants and fellow-colonists with the Anglo-Saxon, having (as seeds) accompanied him across the Atlantic, and having, like him, asserted their supremacy over and displaced a certain number of natives of the soil.

¹ A lecture by Sir Joseph Dalton Hooker, K.C.S.I., Pres. R. S., delivered on April 12, 1878, before the members of the Royal Institution of Great Britain. [Reprinted from the *Gardeners' Chronicle*, August, 1878.]

² Lord Auckland's island, south of New Zealand.

Turning to the hotter parts of North America, the same process of invasion by natives of the Old World is going on: a British-Indian plant¹ has established itself in the streets of Savannah, and so entirely simulated the habit of a native weed, that American botanists gave it a new name, regarding it as indigenous; and one of the most curious cases of plant invasion known to me is that of the mango tree in Jamaica, which reminds one of the accounts of captured tribes, which, after being carried into their conqueror's country, have so increased and multiplied, as eventually to dispossess and supplant their captors. In 1782, Admiral Rodney took a French ship, bound for St. Domingo from Bourbon, with living plants of the cinnamon, jack-fruit and mango, sent to the botanical gardens of the former island by that of the latter. These undistinguished prizes the Admiral presented to the Jamaica Botanical Gardens.

There the cinnamon was carefully fostered, but proved to be (as it is to this day) difficult of culture in the island; whilst the mango, which was neglected, became in eleven years as common as the orange, spreading over lowlands and mountains from the sea-level to five thousand feet above it. On the abolition of slavery immense tracts of land, especially coffee estates, relapsed to a state of nature, and the mango being a favorite fruit with the blacks, its stones were flung about everywhere, giving rise to groves along the roadsides and settlements; and the fruit of these again, rolling down hill, gave rise to forests in the valleys and on their slopes. The effect of this spread of the mango has been to cover hundreds of thousands of acres, and to ameliorate the climate of what were dry and barren districts, by producing moisture and shade, and by retaining the rainfalls that had previously evaporated, besides affording food for several months of the year to both negroes and horses. It may well be, that by future generations in Jamaica, Admiral Rodney will be known less for his victory over Count Grasse, and being the first to "break the enemy's line" than as the capturer of the mango tree in the Spanish Main.

And it is the same in all countries colonized by the Anglo-Saxon; so firmly have the plants he has brought with him established their foot, or rather, roothold in the soil, that were he and all other evidence of his occupation to disappear from North

¹*Fragaria indica* Andr. (*Potentilla durandii* Torr. and Gr.).

America, these, his fellow-emigrants, would remain as witnesses of his former presence, not only on the shores and in the forests of the older States, but in the interior prairie and the newly settled valleys of the Rocky mountains themselves.

Time does not permit me to dwell longer upon this subject of immigration during the historic period. I must now hasten to consider the flora of North America as it was for an indefinite period before the arrival of the Anglo-Saxon, embracing pre-historic and geological epochs; we have to regard this flora as a whole, and as subdivisible into local floras, characterized by the prevalence of certain assemblages of plants; to connect these local floras with the geographical features of the areas they occupy; to account for their position and composition by a reference to the countries from which their components may have been derived, and to the means of communication which exist, or may in former times have existed with these countries.

Before proceeding with this inquiry I will indicate, with the aid of the map, those prominent features of North American geography, which have regulated the distribution of its plants.

Physical Conformation of America.—In the Arctic regions the three northern continents approach, and the hydrography and geography of these regions favor the assumption that in former times they may have been connected. Next we observe that in the American continent (unlike the European and Asiatic), the great obstacles to the intermingling of floras, the mountain chains, are longitudinal; as are the principal valleys, which are the great aids to their diffusion. If we now run a section across the continent along its principal parallel (that near 40°), which approximately coincides with the isotherm of 55° , we find that it (see p. 5), represents tolerably well any other parallel to it in those meridians in which there is the greatest development of a temperate vegetation. Commencing on the east, there is first the Atlantic seaboard, bounded to the westward by mountain ranges of moderate elevation (rarely attaining 6000 feet), which under various names extend from New Brunswick, in lat. 48° , to Alabama and Georgia, in lat. 34° (and which have been collectively called the Appalachian chain). Westward of this chain are the broad, low well-watered valleys of the Ohio, Mississippi and Missouri, the latter in its intersection with our principal parallel being nearly midway across the continent and 1300 miles from the Atlantic.

From the Missouri the ascent is very gradual to the elevated region of the Rocky mountains, which consist of a complicated series of rocky ridges rarely exceeding 14,000 feet elevation, occupying a belt 300 miles broad from east to west. These ridges inclose very large, well-watered, open grassy valleys, called Parks, the rivers from which usually discharge from the range through narrow gorges, called cañons.

The parks and valleys to the east of the mountainous belt present the gray-green (grassy) vegetation of the prairie, those on the west, the hoary sage-bush (*Artemisia*) vegetation of the dry country to the westward; and these often intersect, so that a transverse ridge may separate a green and well-watered park from a hoary and dry one.

The descent from the Rocky mountains on the west is on to a tract elevated upwards of 4000 feet above the sea, extending for 400 miles to the foot of the Sierra Nevada. This tract is intersected by several short ranges 8000 feet high and upwards; its climate is dry, its soil saline, and many of its rivers lose themselves in salt lakes and marshes, whence the local names of Great basin, and of the Sink, Salt-lake and Desert regions. The Sierra Nevada succeeds, rising steeply to an elevation of 12,000 and sometimes of 15,000 feet. Under various names it traverses America, with little interruption, from Alaska to Southern California, at a distance of one hundred to one hundred and fifty miles from the Pacific; but its breadth is nowhere so great as that of the Rocky mountains. The descent from it to the westward is into the great valley of California, whose floor is raised but little above the sea-level, and between which and the Pacific are the low and narrow coast ranges, of which the southernmost in Southern California unites with the Sierra Nevada.

Turning now to the flora of North America north of the tropic, we find that the distribution of its plants is in remarkable conformity with its geographical and climatal features, being in meridional belts from the Arctic ocean to the gulf of Mexico; the botanical components of these belts differing more and more in advancing south, till in the principal parallel that we have traced, the diversity between the eastern and western belts is greater than between any two similarly situated regions on the globe.

Polar Area.—Commencing in the Polar area, the Arctic American flora, though on the whole a uniform one, is distinctly divisi-

ble into three; the first extends from Behring's straits to the mouth of the McKenzie river, and is marked by the presence of certain Asiatic genera and species that advance no farther eastward; the second extends thence onwards to Baffin's bay, and presents various American genera and species not found either eastward or westward of it; and the third is that of Greenland, which is almost exclusively European, and presents several anomalies which I shall hereafter discuss. Besides this eastern and western distribution of the Arctic flora, it streams southward along the three meridional mountain chains of the continent.

British North American Flora.—South of the Arctic flora is that of the British possessions, that is, of temperate America north of the 47th parallel; it consists of a mixture of North European, North Asiatic and American genera, in very different proportions, disposed in five meridional belts. 1, to the eastward, the Canadian forest region; 2, the woodless region, a continuation of the prairie region farther south; 3, the Rocky mountain region, where Mexican genera appear; 4, a dry region, a continuation of the Desert or Sink regions to the south of it; and 5, the Pacific region, which assimilates very closely in its vegetation to that of Kamtschatka.

United States Flora.—It is on entering the United States that the flora of temperate North America attains its great development of genera and species in all the meridians, and that the boundaries of the meridional belts of vegetation are most strictly defined.

I. The great eastern forest region, extending over half the continent, and consisting of mixed deciduous and evergreen trees, reaches from the Atlantic to beyond the Mississippi, dwindling away as it ascends the western feeders of that river on the prairie. It is noteworthy for the number of kinds especially of deciduous trees and shrubs that are to be found in it, even on a very limited area. Of this I shall select two examples from my journal. One was a patch of native forest a few miles from St. Louis, on the Missouri, where in a little more than half an hour, and less than a mile's walk, I saw forty kinds of timber trees,¹ including eleven of oak, two of maple, two of elm, three of ash, two of walnut, six of hickory, three of willow and one each of

¹For the indication and names of them I am indebted to Dr. Engelmann, of St. Louis, who took me to the forest.

plane, lime, hornbeam, hop-hornbeam, laurus, drosyros, poplar, birch, mulberry and horse-chestnut; together with about half that number of shrubs.

The other example was afforded me by Goat island, which divides the great cataract of Niagara, and covers less ground than Kew Gardens. Here the vegetation was more boreal and less varied than in Missouri; but with Dr. Gray's aid I counted thirty kinds of trees, of which three were oaks and three poplars, together with nearly twenty different shrubs.

I know of no temperate region of the globe in which any approach to this aggregation of different trees and shrubs could be seen in such limited areas, and perhaps no tropical one could afford a parallel.

No less remarkable is the composition of the flora of the Eastern States. Prof. Gray has shown that most of its genera are common to Europe and Asia, but that very many are all but confined to North-eastern Asia and Western America. This generic identity, however, gives but a faint idea of the close relationship between the East American and East Asiatic, especially the Japanese, floras, for there is further specific identity in about two hundred and thirty cases, and very close representation in upwards of three hundred and fifty; and what is most curious is, that there are not a few very singular genera, of which only two species are known, one in East Asia, the other in East America; and in some of these instances the Asiatic species is a wide-spread plant in East Asia, whilst the American is an extremely scarce and local plant in its country, which with other considerations render it conceivable that the Asiatic element in East America is a dying-out one.

Leaving out of consideration the purely American genera of this flora, there remain the genera common to Europe, Asia and America; the genera confined to America and Asia; and the genera confined to America and Europe. I shall give an illustration of the proportions in which these occur by a reference to the principal trees and large shrubs only, their names being familiar to you, though the smaller shrubs and herbs afford infinitely more numerous and striking examples; thus, of those common to the three northern continents, I find in America thirty-eight genera with about one hundred and fifty species; these include maples, ashes, hollies, elms, planes, oaks, chestnuts, nut,

hornbeam, birches, alders, willows, beech, poplars, &c. Of those confined to America and East Asia I find in America thirty-three genera and fifty-five species, including magnolias, tulip tree, negundo, wistaria, Virginia creeper, gleditschia, hydrangea, liquid-amber, nyassa, tecoma, catalpa, diospyros, sassafras, benzoin, mulberry, walnut and others which, not being European, are unfamiliar to you. Lastly, of those confined to Europe and America I find only one genus, namely, the hop-hornbeam, of which there is but a single representative in each country.

Here, then, is conclusive evidence of the close botanical relationship of North-eastern Asia and Eastern North America; a relationship of which there is but little evidence in the vegetation of the prairies and Rocky mountains, and still less, perhaps, in the regions farther west.

II. The prairie region succeeds a grassy land with many peculiar herbaceous American genera, including Mexican types, of which last the most conspicuous are a yucca and cacti, which latter increase in number as the Rocky mountains are approached, where they form a noticeable feature in the landscape.

In the parks and lower valleys of the Rocky mountains, deciduous trees are few and scattered, and the forest is an open one of conifers, amongst which a pine, allied to the American nut-pines, *P. edulis*, first appears. Higher on the mountains the coniferous forests are dense, and almost the only deciduous tree is an aspen, which forms impenetrable brakes on the slopes and in the gullies. Above the forest region are the sub-alpine and alpine regions, presenting a mixture of European, Asiatic and American types.

III. Descending to the Sink region the cacti and yucca almost disappear, though they increase to a maximum farther south in this meridian. Deciduous trees are very few, and confined to the gullies of the mountains, and Mexican genera increase in numbers. The hoary sage-bush (*Artemisia*) covers immense tracts of dry soil, and saline plants occupy the more humid districts.

Another nut-pine of Mexican affinity (*P. monophylla*) traverses the center of this region in a narrow meridional strip, and the proportion of endemic plants, herbaceous especially, is very large.

IV. The Sierra Nevada is clothed with the most gigantic coniferous forest to be found on the globe, amongst which a very few species of deciduous trees are scattered; but none of these are

identical with trees of the eastern forests, though several are representative of them. New Mexican genera occur at all elevations from the crest of the range to its base, and thence extend across the Californian valley and the coast-ranges to the Pacific, mixed with northern West American genera and species.

In this slight outline of the botanical features of temperate and Arctic North America, I have alluded to three as most noteworthy, namely: the vegetation of Greenland, the Asiatic character of the vegetation of the eastern half of the continent, and the more southern and even Mexican character of the vegetation of the western half. How are these features to be accounted for?

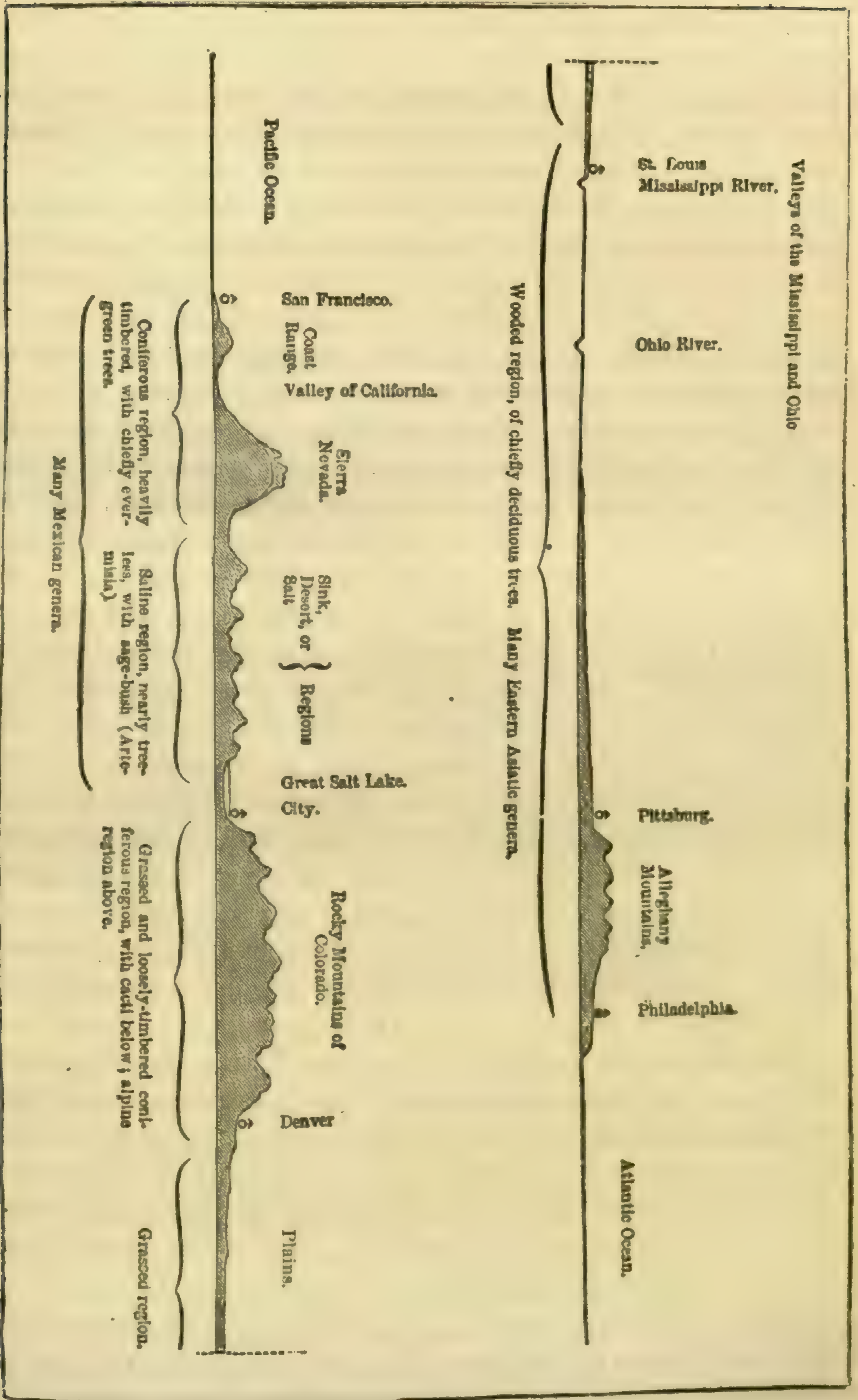
It so happened that Dr. Gray, Prof. of Botany in Harvard College (Cambridge), and I were contemporaneously, but without concert, engaged in botanical investigations which have resulted in explanations of the two first features. He was at work on the flora of Japan,¹ I on that of the Polar zone,² and we were both bringing to bear upon our subjects considerations regarding the variation of species which Mr. Darwin³ almost simultaneously laid before the public, and which, I need not say, powerfully directed our studies.

The Greenland Flora.—I shall take the vegetation of Greenland first, as being first in order, though second in date of appearance and least in importance. Its chief peculiarities are: 1, that its plants are almost all of them Scandinavian (that is, North-west European), hardly any of the peculiar plants of the American arctic sea-coast and polar islands crossing Baffin's bay and Davis straits; 2, that of its three hundred flowering plants hardly any present even a variation from their Scandinavian prototypes; 3, that it is poorer in species than is any other division of the arctic flora, and wants many Scandinavian plants that are found in most other arctic countries; 4, that though Greenland extends four hundred miles south of the Arctic circle, its extra-arctic continuation adds only about one hundred species to the flora, and these

¹ "Observations upon the Relations of the Japanese Flora to that of North America, and of other parts of the North Temperate Zone." *Memoirs of the American Academy of Sciences*, Vol. VI, p. 377. Read December 14, 1858, and January 11, 1859.

² "Outlines of the Distribution of Arctic Plants." Read before the Linnæan Society of London, June 21, 1860. *Trans. Linn. Soc.*, XXIII, p. 257.

³ "On the Tendency of Species to form Varieties," by C. Darwin, Esq., F.R.S., and Alf. Wallace, Esq. Read July 1, 1858. *Journal of the Proceedings of the Linnæan Society of London*, Vol. III (Zoölogy), p. 45.



Section of North American Continent in about Lat. 40°.

all cross the Arctic circle in other longitudes; 5, some Greenland species are confined to it and to the mountains on the Atlantic

side of America, being found nowhere else in Arctic or Subarctic America.

My explanation of these anomalies was, that at a period previous to the glacial, a flora common to Scandinavia and Greenland was spread over the American polar area, and that on the accession of the cold of that period this flora was driven southwards, and was affected differently in different longitudes. In Greenland many species were exterminated, being as it were driven into the sea at the southern extremity of the peninsula, where only the hardiest survived. On the return of warmth the Greenland survivors migrated northward, peopling the peninsula with the hardiest of the species of its former flora, unmixed with American species; and unchanged in aspect from never having been brought into competition with those of any other flora. On the other hand, the same Scandinavian plants when driven south on the plains of the continent multiplied there in individuals, and being brought into competition with American species descending from the continental mountains on to the plains, assumed varietal forms. On the return of warmth, therefore, many Scandinavian species that had been exterminated in Greenland would, having survived on the continent, travel northwards on it, some unchanged, others under varietal forms, accompanied with the American species that had descended from the mountains during the cooling of the continent. Lastly, as some of the Scandinavian species were no doubt local, and confined to near the meridian of Greenland, it is not surprising to find that a few such should survive only in Greenland and on the eastern alps of North America.

Thus only could I satisfactorily account for the almost complete identity of the Greenland flora with the Scandinavian after such changed conditions of climate; for the paucity of its species; for the absence in it of varieties; for the rarity in it of peculiarly American species; for the few species which extra-arctic Greenland adds to its arctic flora; and for certain of its plants being limited in range to Greenland and the eastern American alps.

North Asiatic and North American Floras.—The relationship between the flora of North-east Asia and Eastern North America has been fully explained by Dr. Asa Gray in an essay on the flora of Japan, which is the first entirely satisfactory contribution of its kind to the science of botanical geography known to me.

After a detailed comparison of the botany of Japan and North America, and proving their affinity, Prof. Gray refers to the fact that many of the existing genera and even species of both floras coëxisted in the high latitudes of America during Miocene times, as shown by Heer and other palæontologists; during which period he further assumes that the three northern continents were conjoined, or so nearly contiguous as to allow of a commingling of their floras.

The glacial period followed, carrying an arctic climate south to the latitude of the Ohio, but so gradually, that these plants were not exterminated, but wholly or in part driven southward, followed in the rear by the arctic vegetation. As the temperature rose with the retreating ice, this flora returned northward, leaving the arctic and sub-arctic plants on the mountains of both East and West America.

He next shows that the retreat northward was to a somewhat higher latitude than the same plants now attain; and this he accounts for by a reference to the fluvial epoch of Dana,¹ when the region of the great lakes was submerged five hundred feet below their present level. This diminished area and lowered elevation of the land, by inducing a milder climate than now obtains in the lake region, favored the extension of the flora to a higher latitude than it now attains, and hence effected a second commingling of American and Asiatic plants. Lastly, Dana's Terrace epoch supervened, when the previously depressed northern region was again raised, cooling the climate, finally dissociating the Asiatic and American floras, and giving to the arctic and sub-arctic plants of the continent their present limits.

It remains now to account for the great rarity of East Asiatic types in America west of the prairies, and the presence in those meridians of Mexican and still more southern ones. Hitherto there have been no other attempts at a solution of this problem than such unsupported speculations as that the western half of the continent, though so much the loftier, was submerged during the southern migration of the northern miocene plants; or that the climate of the West was unsuited to the habits of these, which

¹ Whilst these pages were still in the press, Prof. Gray has informed me that he now lays little stress on the conditions supposed to be due to the terrace and fluvial epochs; and that he is rather disposed to consider the separation of the northern floras by the Glacial epoch to have been final.

appears to me to be at variance with the fact that when imported into it they thrive luxuriantly.

The explanation which I have to offer will be best understood by a reference to the section (p. 163), which shows the western half of the continent to be enormously elevated as compared with the eastern, and to have been singularly adapted for the retention of vast bodies of ice for long after the Glacial period. We find there a valley (the desert region), upwards of four hundred miles broad, and upwards of four thousand feet elevation, with many ranges of over eight thousand feet in it, bounded by broad and lofty mountains, together occupying at least two-thirds of the breadth of the western half of the continent. We further know that these mountains were clothed with ice during the Glacial epoch, and that the valley was then occupied by a vast lake; for on the uppermost of the many shelves which the retiring waters of this lake cut on the flanks of the Rocky mountains and Sierra Nevada, the skull of the musk-ox, the most arctic of land quadrupeds, has been found.

It is obvious that this whole western region must have retained its glacial mantle for an incalculable period after Eastern America had been sufficiently warmed to admit of the northward return of the plants that had been driven southward in it; and that this glaciated condition must have effectually barred a similar return of the same plants in those western meridians, these must have perished, in short, on reaching Southern California. Long ages after, when the western ice disappeared, and the climate of the valleys warmed, the Mexican and more southern plants would, as a matter of course, take possession of the unoccupied soil, and advance northward till they encountered the boreal vegetation of North-western America, with which they now commingle.

I have said that the extinction of East Asiatic types in Western America was not total; a few escapes are found in the valleys of the Rocky mountains and Sierra Nevada,¹ and also along the coast of the Pacific, the warming influence of which favored their preservation during the northern migration.

The Sequoias.—Two instances of these escapes are of such interest that I shall, in concluding this lecture, bring them under your

¹ And also on the highlands of Central Mexico, where some Asiatic types remain which have not migrated farther north or south in America. Such are the eminently Asiatic genera *Bocconia*, *Meliosma*, *Photinia*, *Cotoneaster*, *Deutzia* and *Abelia*.

notice; they are those giants of the vegetable kingdom, the Sequoias, the red-wood (*S. sempervirens*), and the "big-tree" or "Wellingtonia" (*S. gigantea*).

The fossil remains of these trees, or species most closely allied to them, are found in Miocene beds in high latitudes all round the globe; in Vancouver's island, Sitka, on the arctic American sea-coast, in Greenland, Spitzbergen and in arctic Asia, &c. The genus, therefore, which first appeared in the Cretaceous times, was undoubtedly a member of that mixed Americano-Asiatic flora that was driven southward during the Glacial period. The genus is now confined to Western North America, and to the two above-named species, but it is represented in Eastern America by the very closely allied genus *Taxodium*, and in Eastern Asia by *Glyptostrobus*.

The distribution of the two Sequoias is most instructive. The red-wood forms a dense narrow forest tract for about five hundred miles, skirting the ocean, along whose warmer shore it crept northward after the Glacial epoch. It rivals in height its sister of the Sierra, and attains an enormous girth and age, though I can find no account of any attempt having been made to estimate its age.

The *S. gigantea*, or "big-tree" (the Wellingtonia of British gardens), again, is a plant of a cooler climate; and hence, having survived the glacial cold, was enabled to establish itself in the Sierra Nevada under certain very restricted conditions. It extends at intervals along the western slope of the Sierra to a little north and south of the parallels of 36° and 38° N., that is, for nearly two hundred miles in a north-west and south-east direction, at elevations of five thousand to eight thousand feet above the sea. Towards the north the trees occur as very small, isolated, remote groves of a few hundreds each, most of them old and interspersed amongst gigantic pines, spruces and firs, which appear as if encroaching upon them; such are the groves visited by tourists (Calaveras, Mariposa, &c.). To the south, on the contrary, the big-trees form a colossal forest, forty miles long and three to ten broad, whose continuity is broken only by the deep sheer-walled cañons that intersect the mountains; here they displace all other trees, and are described as rearing to the sky their massive crowns; whilst seen from a distance the forest presents the appearance of green waves of vegetation, gracefully following the com-

plicated topography of the ridges and river basins which it clothes.

But by far the most remarkable fact hitherto reported regarding the disposition of the groves is, that they occupy only those spots in the Sierra which were first laid bare when its icy mantle became broken up into isolated glaciers. Thus, commencing at the north, the gap of forty miles between the Calaveras and Tuolumne groves was occupied by the great glacier of the Tuolumne and Stanislaus rivers; that between the Merced and Mariposa groves by the glacier of the Merced river, which sculptured the famous Yosemite valley; and so on—each successive group of trees occupying a lofty spur between the sites of ancient glaciers, and the greatest continuous extension of the forest (of forty miles) occurring exactly where, owing to the topographical peculiarities of the region, the ground was most perfectly protected from great fields of ice.

Mr. Muir, a very intelligent and accurate observer, who has studied the groves throughout their length and breadth most diligently,¹ and to whom I am indebted for the above and much other information regarding the southern forest of Big-trees, considers that these have never since the Glacial epoch been more widely distributed or in greater vigor than now, and doubts, indeed, if the forests have reached their prime, founding his opinion on the high state of health of the mass of the trees, the multitude of seedlings and saplings in the southern groves, and the absence of any trace of trees having existed outside the present limits of the groves (as of dead trees, stumps, or the great holes left by fallen trees).

Size of the Big Trees.—So little that is trustworthy has hitherto been published regarding the age, size and durability of the Big-tree trunks when fallen, that I shall offer you some accurate data which I obtained on these points chiefly from Mr. Muir. A tree felled in 1875 had no appearance of age, it was 69 feet in girth inside the bark, and the number of annual rings counted by three persons varied between 2125 and 2139. Another was 107 feet in girth inside the bark at four feet from the ground; its wood was very compact, and showed, throughout a considerable portion of the

¹ 'On the Post-Glacial History of *Sequoia gigantea*,' by John Muir, of San Francisco, Cal. Proceedings of the Amer. Assoc. for the Advancement of Science, Buffalo meeting, Aug., 1876.

trunk thirty annular rings to the inch. This, if the rings were of uniform diameter in the rest of the trunk, would give the incredible age of 6400 years; but as the interior rings of such trees are much broader than the outer, half that number to the inch is a more conceivable estimate, which would give an age of 3200 years. The only other instance of careful counting of rings which I can find is that of the felled tree in the Calaveras grove, which measured seventy feet girth inside the bark at six feet above the ground, and which at forty feet above the ground had 1255 rings. In this case the rings next the bark were thirty-three to the inch, a number which at five feet inward had diminished one-half. The result of many measurements, chiefly by Prof. Whitney,¹ gives, as the average height of full-grown trees, 275 feet, and a maximum a little over 320; a girth outside the bark, at six feet above the ground, of seventy, with a maximum of 120; whilst the maximum age possibly attained may be 4000 years, though this is very improbable.

The duration of the dead wood in the forest is very great. I rarely observed signs of rot in the fallen trees I examined, whilst in similar forests in North California I saw gigantic trunks of silver firs forming mounds of rotten *débris* without an atom of sound wood, and this in two years after their fall, as I was assured. I had no data for ascertaining the length of time during which any of the prostrate Sequoia trunks which I saw may have lain on the ground, but Mr. Muir has supplied me with a very crucial case. It is that of a prostrate trunk with no signs of decay in any part of it, which had been burnt in two by a forest fire, and in the trench between the severed portions of which a silver fir grew. This fir was felled, and had 380 annual rings; therefore, to estimate the time during which the Sequoia trunk had lain uninjured, we must add to the 380 years, first the time it lay before the forest fire burnt it in two, and then the unknown interval between that time and the arrival of the silver fir seed.

The millenia during which these Sequoia trees must have remained *in statu quo*, proving the long duration of existing conditions of climate, are but as minutes compared with the time occupied by the migration of this very species, or its ancestors,

¹Very careful measurements of the trees in the Calaveras and Mariposa groves are given by Prof. Whitney (State Geologist) in the Yosemite Guide-Book, published under the authority of the Geological Survey of California (1874).

north and south in the continent of America. Whatever might otherwise be the extent of the Sequoia's travels, they are now at an end. Man has pronounced the sentence, "Thus far shalt thou go, and no farther!" The doom of these noble groves is sealed. No less than five saw-mills have recently been established in the most luxuriant of them, and one of these mills alone cut in 1875 two millions feet of Big-tree lumber; and a company has lately been formed to cut another grove. In the operations of the California wood-cutters the waste is prodigious. The young, manageable trees are first felled; after which the forest is fired to clear the ground and get others out, and thus the saplings are destroyed. More destructive still are the operations of the sheep-farmers, who fire the herbage to improve the grazing, and whose flocks of tens of thousands of sheep devour every green thing, and more effectually than the locust. The devastation of the California forest is proceeding at a rate which is utterly incredible, except to an eye witness. It is true that a few of the most insignificant groves of the Big-trees at the northern extreme of its range are protected by the State Legislature, and that a law has been enacted forbidding the felling of trees over fifteen feet in diameter, but there is no law to prevent the cutting or burning of the saplings, on which the perpetuation of the grove depends, or to prevent the burning of the old trees, which, if they do escape the fire, will succumb to the drought which the sweeping away of the environing forest will occasion.

During the last quarter of a century the Anglo-Saxon has been ruthlessly carrying fire and the saw into the forests of California, destroying what he could not use, and sparing neither young nor old, and before a century is out the two Sequoias may be known only as herbarium specimens and garden ornaments; indeed, with regard to the Big-tree, the noblest of the noble coniferous race, the present generation, which has actually witnessed its discovery, may live to say of it, that "The place which knew it shall know it no more."