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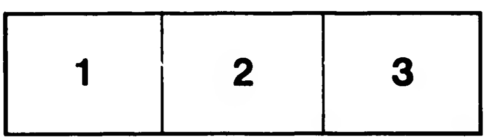
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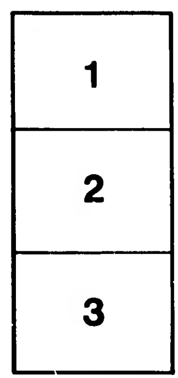
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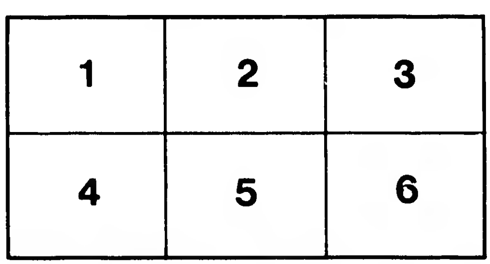
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CLIMATES

OF THE

NORTHWEST;

BEING

CONDENSED NOTES OF A LECTURE

DELIVERED BY

HON. S. GARFIELDE,

Delegate in Congress from Washington Territory.

PHILADELPHIA:

1871.

Ringwalt & Brown, Prs.


MAP OF THE NORTHERN PACIFIC RAILROAD AND ITS CONNECTIONS
NATIONAL RAILWAY PUBLICATION CO. PHILADELPHIA
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JAMES BAY
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UNITED STATES
ATLANTIC OCEAN
PACIFIC OCEAN
WASHINGTON
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IDAHO
MONTANA
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WYOMING
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KANSAS
NEVADA
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NEW MEXICO
INDIAN TERRITORY
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ARKANSAS
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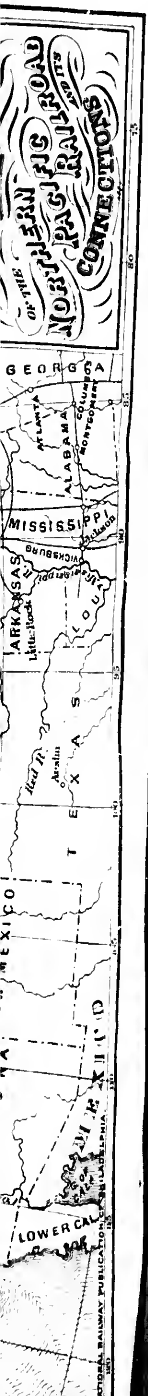

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CLIMATES OF THE NORTHWEST.

An almost continuous residence for more than twenty years upon the Pacific slope and in the interior regions of the Continent, much of which time was spent in travel by sea and land, has brought me face to face with nearly all the topographical and climatic conditions of the country lying west of the Mississippi. These in all essential particulars differed so widely from those of the Atlantic regions, that observation was awakened, and inquiry into the causes of difference stimulated.

Some of the results of these observations and inquiries have been condensed in the form of a lecture, brief notes of which are now published more for the benefit of those who are inquiring for new homes in the far west, than for scientific climatologists. If they shall contribute in any measure to a better popular understanding of the climatic conditions of the western half of the Continent, the object of their publication will have been accomplished.

The *facts* stated in the following pages may be relied upon as substantially correct—nothing having been set down as such except the personal observations of the writer and the experiences of most reliable men long familiar with given districts of country. The reasonableness of *causes*, when presented, and their sufficiency to produce the results stated, must be determined by the reader.

It will not be claimed that the country known as the "Great West," taken as a whole, will compare favorably, acre for acre, with the region already populated. But in delightfulness and salubrity of climate, magnificence of scenery and variety of resources, much of it far exceeds any portion of the country lying east of the "Father of Waters;" while the composition of the atmosphere, the general temperature and the sublime and strongly contrasted scenery produce an exuberance of spirits, a luxury of existence, an intense enjoyment of animal life nowhere else experienced upon the Continent.

We enjoy by contrast. Hence our strife to out-dress, out-build and out-improve our neighbors. A brown-stone house and costly apparel would afford but little satisfaction to the possessor in a city where all the dwellings and apparel of the people were exactly alike. Hence the constant effort at the unique and novel, as well as the beautiful. The valley which, upon the plains of Illinois, would appear tame and unnoticeable, becomes extremely interesting when set in a rim of bristling mountains. The lake which, with its reedy shores, miry banks and stagnant waters, becomes an object of aversion in a country of flat and undiversified prairies, springs into life and at once challenges attention when surrounded by pebbly shores, or is found nestling among rocks or rippling to the breeze in a country diversified by hill and dale, prairie and woodland. Contrast is the rule of the West as tameness and uniformity are of the Mississippi valley and much of the East.

But, as with the emigrant the useful supersedes the merely beautiful; and as food, raiment, health and comfort are the objects sought by those who leave their homes for a life in the West, the subject will be considered in its practical and economical aspects, leaving a discussion of the effects of varied and contrasted scenery, pure water and highly oxygenized air upon the intellectual and moral, social and domestic life of a people, to the possibilities of a future occasion.

CLIMATE, in its more extended sense, embraces a great variety of phenomena. But two of these can be even partially considered within the limits of a lecture, viz.: *temperature* and the *precipitation of moisture* in the form of rain and snow, with the causes of their unequal and irregular distribution over the region under consideration.

The popular mind has accepted a supposition that degrees of latitude indicate the relative temperature of localities. When, therefore, it is stated that an unknown locality, like Puget Sound or British Columbia, lies in the same latitude as Labrador or Quebec, the inference is at once drawn that it possesses a bleak and inhospitable climate. In point of fact this conclusion is very far from the truth. Were the earth a perfect sphere, without protuberances to interfere with the circulation of the air, or continents to arrest or control the currents of the ocean, then might places in corresponding latitudes have the same climate; but there exist so many disturbing causes that the determination of local climates by analogy or inference is wholly impracticable.

In order to present climatic irregularities to the eye, climatologists draw upon the surface of the earth certain lines termed *isothermal*, each line passing through all points having an equal average *annual* temperature. Other lines, indicating equal *summer* temperatures, are termed *isotheral*, while those applicable to *winter* are called *isochimenal*. The isotheral and isochimenal lines, which, on the eastern portion of our Continent, follow approximately the lines of latitude, have a remarkable trend to the north-west after leaving the region of the great lakes, while in many places on the Pacific coast they run nearly north and south. The northern limit of profitable wheat culture, which is the isotheral of 60°, pursues a very devious course across the Continent. Commencing on the Pacific coast at lat. 52° N., it extends as far north as lat. 56° in the region east of the Rocky Mountains, passes north of Lake Winnipeg, and thence traverses the southern slope of the water-shed between Hudson's bay and the Lake Superior basin, until it reaches the longitude of James bay, where it enters a region known only to lumbermen and hunters. So also the isochimenal line, which passes through the city of Norfolk, Va., in lat. 37°, crosses the northern end of Vancouver island, in lat. 51°—a difference of fourteen degrees. To understand the reason of these variations of temperature, and in order to render the statement of fact credible, a short inquiry into the agencies which control the distribution of heat must be instituted.

Climates, so far as temperature is concerned, depend mainly upon three causes:

1st. The action of the sun's rays upon the surface of the earth.

2d. The movements of the earth in its orbit and upon its axis.

3d. The topographical features of the earth as to relative elevation, and the position and configuration of continental masses.

To present the action of these causes in their order, we will suppose the rotary motion of the earth to be suspended and its entire surface covered with water of a uniform depth. The effect of solar heat can now be observed. That portion of the surface subject to the vertical rays of the sun becomes greatly heated, while the regions north and south are less heated as you recede from the equator and the sun's rays strike the surface more obliquely. The atmosphere within the tropics now expands by heat, and, becoming lighter, ascends into the upper regions, while the lower and cooler strata flow in from the north and south to supply the vacuum. Thus is established a surface current from the cooler to the warmer regions, causing a constant north wind in the northern hemisphere, and a constant south wind south of the equator. Without counter currents, this process would pile up the entire atmosphere in the equatorial regions like an immense mountain chain, having its axial line on the equator and extending east and west around the globe. As it is, this piling-up process, resulting from these atmospheric movements and the rotary motion of the earth, causes an equatorial atmospheric elevation of about four miles. But as the heated air ascends, it flows off north and south, down the slopes of this atmospheric mountain range until it reaches regions of greater cold near the poles, where, condensing, it gradually reaches the surface of the earth and returns again towards the equator as a cold surface current. Thus the simple action of the sun's rays would produce constant *surface* currents from the poles towards the equator, and constant *upper* currents from the equator towards the poles. The same cause would produce somewhat similar oceanic movements, which will be considered in another place. The action of the sun's rays, when taken alone as controlling the distribution of heat, would give equal climatic conditions upon equal latitudes. It will readily be seen that this constant aerial and aqueous circulation must modify the rigors of the polar regions and cool the parched surface of the tropical districts. Indeed, it is probable that were this circulation arrested, animal life would become extinct within the tropics and above lat. 40°, north and south, leaving but two narrow belts of the earth's surface habitable.

Having stated the simple action of the sun's heat in producing aerial and oceanic currents and the distribution of temperature over the surface of the globe, we will restore the rotary motion of the earth and observe the effect of this disturbing cause. If you rotate two wheels of unequal diameters fixed to the same axis, you will at once perceive that the periphery, or extreme surface, of the larger wheel passes through a greater space in a given time than the smaller—in other words its periphery moves faster. So also the motion of the earth's surface in the equatorial regions is much greater than near the poles, because of the greater diameter of the rotating mass at the equator.

As the atmosphere moves from west to east with the earth in its rotation, it follows that a current of air moving from the poles, where the rotary motion is comparatively slow, towards the equator, where the same motion is rapid, must *fall behind* the movement of the earth, and, to an observer stationed in its course, appear to come from the eastward. Therefore, the result of a northerly current falling behind the earth's motion is to produce a northeast wind. On the other hand, the upper currents, moving from the region of the earth's greatest diameter and consequent greatest motion, towards the poles, must move *ahead* of the earth's rotary motion, and appear to an observer to come from the westward. Hence the result of a southerly current moving ahead of the earth's motion is to produce a southwest wind. But this latter wind will not be felt in the lower latitudes, being there an upper current. As it moves northward however, it becomes cooler and gradually descends until, in the winter when the sun is south of the equator, it reaches the surface in about lat. 30°. In the summer, when the sun is north of the equator and the whole northern hemisphere is heated up by its rays, this S. W. wind does not probably reach the surface below lat. 65° or 70°, except when portions are forced down by the convergence of the meridians of longitude; but, moving ahead of the earth's rotary motion, it sweeps around the pole, forming a vast aerial vortex, and moves southward again as a northwest wind.

Taking therefore the action of solar heat and the rotary motion of the earth, together with the revolution of the earth around the sun, and the inclination of its axis, producing the vicissitudes of the seasons, we should have calms, variable winds and vertical currents, as the results of expansion, in the equatorial regions—northeast winds from there to lat. 25° or 30°—variable winds where the S. W. currents begin to reach the surface just north of the N. E. winds, and southwest winds in winter and northwest winds in summer further north. These conditions are found to exist in fact wherever unobstructed by other disturbing causes.

Instead, however, of the earth being a smooth surface, covered by an ocean of uniform depth, we find continents and islands of irregular shape, and unevenly distributed, occupying a considerable portion of the surface. Vast ridges and peaks rise from the dry land to obstruct and divert the winds, and furrows, gorges and cañons of profound depths, influencing and often controlling the oceanic currents, sear the bed of the sea in every direction. These break up the uniform aerial and aqueous movements stated above, and produce that seeming confusion of currents, which has been the study of climatologists and physical geographers for many years past. It cannot be doubted that the configuration of continents and islands, and the direction of the deep grooves in the bed of the ocean largely influence the direction and velocity of oceanic currents. And when it is considered that one-half of the atmosphere surrounding the globe is condensed by the pressure of its own weight within a space of three or four miles in height, being below the tops of the higher ranges of mountains, the irregularities of the surface will be admitted to materially affect, and even control the direction of the winds in their vicinity, together with the phenomena dependent thereon.

It remains to consider the operation of these various causes upon the climates of the interior and western coast regions of the Continent. The Pacific ocean, being the largest area on the surface of the globe which presents an even spherical surface, should be least subject to the variations and irregularities which are so common in most other localities, and should indicate, with the least disturbance, the effects of the distribution of solar heat and the rotary motion of the earth in the production of atmospheric and oceanic currents. The prevailing winds of the temperate zone, where unobstructed, being westerly, should give the Pacific coast regions of this Continent a climate of greater uniformity than that which obtains in the interior and eastern districts. Such, by observation, is found to be the case.

From the equator to lat. 12° or 15° north, being a part of the region of equatorial calms, there is but little wind and that variable. From thence to lat. 25°, the N. E. trades prevail. On about this latitude, the upper southerly current begins to reach the surface in winter and, moving in a direction opposite to the N. E. trades, breaks them up and produces a belt of variable winds which extends as far north as lat. 32°. Beyond this limit northward, the S. W. winter winds, which have now reached the surface in full force, sweep forward with almost uninterrupted regularity wherever unobstructed by surface elevations. These S. W. winds, together with the oceanic currents, which will be treated of presently, fully account for the mildness of the winters along the Pacific coast from San Francisco to Sitka. As far north as lat. 49°, flowers bloom and vegetable life is active far into the winter season. Frost seldom continues more than from four to fifteen days during the entire winter, while ice for domestic uses is the exception rather than the rule. But little snow falls, not enough to obstruct or facilitate locomotion. The average temperature of winter is 39°.

As the sun moves northward across the equator and spring advances into summer, the S. W. winter winds gradually die out, or rather, move on to the north as upper currents, being constantly rarified and held in suspension by the increasing power of the sun's rays; while the regions below are fanned by variable breezes, mostly from the westward. This view is strengthened by the long-observed fact that these S. W. winds first begin to disappear in spring in the region where they first dip to the earth (about lat. 32°), and such disappearance steadily moves northward as the season advances; while in autumn, they first strike the earth far to the north and back down, as it were, until they sweep along the whole coast as far as lat. 32° again.

By the first of June the heat of the sun is sufficient to carry these winds, as upper currents, northward to the polar vortex, where, moving rapidly in advance of the earth's rotary motion, they sweep around the pole and, cooling gradually, descend spirally to the surface over which they pass as N. W. winds. These winds are felt as far south as lat. 32° where they enter the belt of variables, but with constantly decreasing force as the increasing velocity of the earth's surface overtakes their motion.*

The present is not a fitting occasion to indulge too freely in speculations,

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* I am aware that this statement is not entirely in consonance with the popular theories of the day, nor with the speculations of Maury, but it is presented as affording, perhaps, a better explanation of phenomena as they may be observed on the Pacific (where but few causes of disturbance exist), than any other yet offered.

but it may be suggested in passing, that the northern explorations so vigorously prosecuted in the present age, may establish the existence of this atmospheric vortex north of lat. 70°, and an intimate connection between the atmospheric gyrations there supposed to exist and the phenomena of the *aurora borealis*. It is a well-known fact that electrical phenomena usually accompany rotary movements of the air.

During the heated term, from June to October, these N. W. winds prevail along the coast. Coming from high latitudes and sweeping over a cold ocean, they are cool and dry, modifying the heats of summer and reducing the average temperature to about 64°. The nights are specially noticeable, being clear and deliciously cool, thus enabling nature to restore the energies exhausted during the day.

This equability of climate (39° in winter and 64° in summer) gives the residents of the coast districts and especially of Puget Sound, the winters of Norfolk, Va., the summers of Nova Scotia, and the same mean annual temperature as Pekin, London, New York and Chicago. The location of these great capitals on this isothermal was not the result of accident, nor wholly of topographic necessity, but largely of man's intuitive perceptions in determining the belt of the earth's surface best adapted to his physical and intellectual development by promoting health and longevity and stimulating the highest activities. Nature herself has designated the locality of the great emporium of the Pacific, and it is the evident destiny of the terminal city on Puget Sound to be worthy of its place as a link in the capital chain which encircles the world.

An application of the principal cause which produces this moderation of temperature on the Pacific coast to your own locality will render the foregoing statements more credible. You have doubtless observed that the continuance of southerly winds for a few days in winter always brings a thaw. Were these winds *continuous*, as they are on the Pacific coast at that season, your winters would be nearly, if not quite, as mild as ours; the farmer would forget to provide hay for his cattle and the earth would bear a carpet of perpetual verdure. So, also, were your northwesterly summer winds constant during the heated term, like ours, your atmosphere would continue fresh and exhilarating and your watering-places and sea-shore resorts would be deserted, for the dog-star would rage in vain.

The causes which produce atmospheric movements, also disturb the quiet of the ocean. All substances expand by heat—water as well as air, although to a much less extent. Hence arise the two principal oceanic movements in the northern hemisphere—the "Gulf Stream" and the "Japan Current." In the great cauldron of the torrid zone, the water is heated even as high as 85°. It consequently expands and flows off to the cooler regions—its place being supplied by colder and heavier water from the north. This, together with the great amount of equatorial precipitation, is believed to produce the ocean currents of our hemisphere, which are crowded against the eastern shores of both Continents by the motion of the earth, until they reach lat. 48° to 56°, where, by their motion being in excess of that of the earth, and by encountering more elevated plateaus of the oceans' beds, they are deflected eastward and break upon the opposite coasts of the respective Continents. This movement of the Gulf Stream is well understood. Leaving the Caribbean Sea and Gulf of Mexico, it moves northeastward along the American coast, gradually becoming an off-shore current, until it impinges upon the grand banks of Newfoundland, where it is deflected to the eastward and, moving along the southern declivity of the plateau upon which the ocean cable from Virgin bay to Valencia rests, crosses the Atlantic and breaks upon the shores of Western Europe. A portion of its volume, escaping over the plateau, moves along the northern coast of Ireland and western coast of Scotland.

Here we have a magnificent river of warm water carrying the heat of the tropics to more frigid regions. This heat is retained intact to a great degree until the current breaks upon the shores, where it is set free, and being carried inland by the prevailing westerly winds, renders all of Central and Northern Europe habitable. Were the Gulf Stream arrested in its flow, the German would become a frozen ocean, the British islands would become another Labrador—would cease to grow wheat and barley, and the people would be obliged to emigrate or perish in a frozen wilderness.

While the Atlantic has its Gulf Stream, the Pacific has one as much grander as the ocean through which it flows. This is called the "Japan Current." It takes its rise in the Indian ocean, moves northward along the eastern shore of Asia, as the Atlantic Gulf Stream hugs the American shore, until it strikes upon the Aleutian Islands and Alaskan Peninsula. Here it is divided. One portion moves northward through Behring sea and straits, eastward through the Arctic ocean, southward through Baffin's bay and Davis' straits, and still southward along our Atlantic coast, giving us cold northerly and easterly winds and good fish. This accounts for the abundance of icebergs in the Atlantic while none are ever seen in the Pacific. The Japan current, flowing from the Pacific into the Arctic ocean and from thence into the Atlantic, carries all icebergs with it.

The other and much larger portion of the Japan current is bent southward by the elevated bed of Behring sea and the Alaskan peninsula, and flows along the western coast of America as an off-shore current, until it strikes upon Cape Mendocino, in California, where a portion turns again northward as an immense in shore eddy, while the remainder moves on southward, until, by its greater specific gravity, it sinks beneath the surface, and is lost. These currents are evidenced by the experience of navigators. Vessels loaded with lumber on Puget sound, and bound for San Francisco and other parts of the world, sometimes encounter squalls and have to be relieved of their deck-loads. If this occur within fifty or sixty miles of shore, the lumber floats northwardly, towards Alaska; if at a distance of one hundred and fifty miles, it floats southwardly, towards Mendocino. This Japan current does not part with all its caloric during its entire circuit of many thousand miles. The volume of water in motion is so wide and deep, that, after having parted with several degrees of its heat along its more northerly course, it scarcely varies two degrees from Queen Charlotte's Island to San Francisco—a distance of more than a thousand miles. Nor does the summer elevate nor the winter lower its temperature to a greater extent. Observations show that 50° in winter and 52° in summer are about its average temperature.

Perhaps no other portion of the Pacific coast is influenced to the same extent in its climatic conditions by the Japan current as the districts bordering the waters of Puget sound. This interior body of tide-water, extending nearly two hundred miles inland, having sixteen hundred miles of shore line, covering at least two thousand square miles of surface, of great depth and ramified by bays, channels and inlets in every direction, has an average tidal rise and fall of about twelve feet—the extremes being eight and twenty-four. Calculating the area of the sound, it will be found that fifty thousand million cubic yards of water are poured into and out of it by the tide every day. In mid-summer, when the other conditions would produce a temperature of 90°, this vast body of water at 52° is poured in daily, and, being 38° colder than the surrounding atmosphere, at once absorbs a portion of the surplus heat, and thus aids the cool northwest breezes in keeping the summer average down to 64°. In winter the same volume of water at 50° parts with its surplus caloric whenever the atmospheric temperature is below that figure, and thus aids the warm southerly winds in keeping the winter average up to 39°. Hence, it will be perceived that Puget sound acts as an immense *heater* to moderate the rigors of winter, and as a *refrigerator* to cool the air during the heated term. This body of water is changed at each ebb and flow of the tide. The in-shore current, which sweeps past the mouth of the straits of Fuca, carries the outflow off to the northward, and each flood-tide brings into the sound a fresh supply of water of uniform temperature with the Japan current.

Proceeding inland from the coast regions of the Pacific, the climate rapidly becomes modified. Many isolated localities have climates peculiar to themselves, so that it is impossible to state many general facts of equal applicability to the whole country. As a rule it may be stated that the extremes of heat and cold increase inland, but in no regular ratio, nor upon given lines of latitude. Two great disturbing causes produce these irregularities—the lofty mountain chains which traverse the country, with their spurs and angles, and the difference of altitude of the interior plateaus.

A hundred miles inland from the coast, and parallel with it, stands a lofty chain of mountains, known as the Sierra Nevada in California, and as the Cascade range through Oregon, Washington and British Columbia. The southwest winds of winter, striking this range at an obtuse angle, are bent in their course and ultimately deflected to the west of north, giving them on land the direction of southeast winds. The upper stratum only of this current escapes over the summit of the range to modify the climate of the interior. The Rocky mountain range—the vertebral column of the Continent—has a general course east of south and west of north. It is broken into more than a hundred ridges, which, with the subordinate ranges, lie in every possible position, and at all points of the compass. These give direction to the prevailing winds and modify the local temperature.

The interior of the Continent, west of the longitude of Omaha, is a vast inclined plane, declining to the north. The elevation at the northern end, in the latitude of the river Saskatchewan, is not much over 1,000 feet above the sea. Southward the surface steadily rises—the Great Salt Lake region and 1,100 miles of the Union and Central Pacific Railroad being nearly 5,000 feet high—2,000 feet higher than the tops of the Allegheny Mountains, while the two summit levels on that route are over 7,000 and 8,000 feet respectively. Further south the table lands increase in height until, upon the plains of Mexico, the altitude is about 8,000 feet. It is well known that temperature diminishes about three degrees for each 1,000 feet vertical. It will thus be perceived that from this cause alone, the region of the Saskatchewan, in British America, is 12° warmer than it would be had it the elevation of the Union Pacific Railroad and 24° warmer than if it had the altitude of the plateaus of Mexico. The Northern Pacific Railroad has an average elevation 3,000 feet less than the Union Pacific, while its summit levels respectively are 3,000 and 4,000 feet lower. This difference of altitude alone compensates for the difference of latitude.

But there are other causes which operate to render the winters in the vicinity and to the northward of the 49th parallel less rigorous, in proportion to their latitude, than those in the districts further south, one of which may be stated here. The two principal chains of mountains before referred to attain their greatest elevation between the thirty-second and forty-fourth parallels of latitude. Further north they are less elevated and present many low and broad passes. In their loftier sections, these mountains operate to shut off the warm S. W. winter winds from the interior and to deflect them to the N. W. along the coast. As they sweep on to the northward, the mountain ridges becoming lower and the gaps wider, they escape over the summits and through the passes, and thus distribute a portion of their heat over the more northerly interior districts.

The constant flow to the eastward, during the winter season, of a great "river" of warm air through the more northerly passes of the Rocky Mountains, was observed and discussed several years since. Lieut. Mullan, of the United States Army, who spent some time in that country, detected its existence, noted its width in some places and sought to account for it. He attributed the elevated temperature of this current to the number of warm springs near the sources of the Missouri, Yellowstone and Columbia rivers. This explanation of course was wholly unsatisfactory. As well might we expect to find a similar current of warm air to the eastward of the city of New York as the result of the heat escaping from the chimney tops of that city. This atmospheric "Gulf Stream" is evidently a portion of the great southwesterly current which sweeps around the world in the temperate zone—as a surface wind wherever unobstructed, but principally as an upper current wherever obstructed by mountain chains and continental masses. These currents, deflected upward by mountain ranges, often return to the surface and produce very marked effects. Upon the great plateau of the Columbia, during periods of severe frost, the S. W. wind, which has escaped over the summit of the Cascade range, sometimes dips to the surface. At once the snow melts, the frost disappears and the temperature becomes mild and genial. As soon as the current ascends, the frost returns and winter resumes its sway. These occasional currents are known as "Chinook winds" and have been the subject of much speculation.

The warm southwesterly winter winds, escaping over the lower portions of the Rocky Mountains, "drawing" through their northerly passes and spreading, like a fan, over Eastern Montana, Dakota and the extensive regions of the Saskatchewan and Assiniboine, together with the lower elevation of the more northerly districts, give them a mildness of climate both incomprehensible and incredible to those who have given the subject no particular attention. But theory and observations both unite in attesting the fact that, from the Pacific coast eastward to the Mississippi, the winters increase in severity upon any given parallel where disturbing causes, like mountain chains or general surface elevation, do not intervene. Thus St. Paul is the coldest point of equal elevation between the Mississippi and Puget sound on that parallel. Indeed, Deer Lodge pass, the highest summit on the line of the Northern Pacific Railroad, affords no lower thermometric range than St. Paul.

To compare the unfamiliar with the familiar, and thus convey a better practical idea of the temperature of the northern belt across the Continent, it may be stated that the maritime districts of Washington Territory and Oregon have the winters of Norfolk, Virginia, and the summers of Nova Scotia. Eastern Washington, northeastern Oregon and northern Idaho about the summer and winter temperatures of central and northern Pennsylvania. Montana and western Dakota assimilate in average temperature to New York and Connecticut, but the valleys of Montana have very little snow, and cattle there require neither winter feeding nor shelter. Eastern Dakota, Saskatchewan and Assiniboine are very much like Minnesota in temperature, although somewhat milder than the eastern portion of that State.

Having rapidly noticed some of the more prominent conditions of temperature in the region under consideration, with their causes, it remains to consider hastily the subject of *precipitation*. The question of the amount of moisture deposited annually upon a given area is one of paramount interest to those who contemplate settlement in a new country. Heat and moisture give fertility to the soil. It matters little how sterile a district may be in its early formation, if these elements exist in due proportion, ultimate fertility must be the result.

The intra-montane and western portions of our Continent derive their moisture from the vast inter-tropical regions of the Pacific ocean. There, where the temperature is high and the water surface extensive, an inconceivable amount of moisture is taken up by solar evaporation. In the northern hemisphere this is carried northward by the upper southerly current of air, begins to descend with that current in about lat. 30°, and is then carried inland by the southwest winter winds, and deposited by condensation. It follows that along the coast the amount of annual precipitation will depend largely upon the duration of these winds. For the reasons already given, they continue longest in the high northern latitudes, while in the vicinity of lat. 30° they last but a few weeks. Accordingly we find that in Sonora and Lower California the period of precipitation is very short, and the rain-fall does not exceed four or five inches. This steadily increases northward, being ten inches at San Diego, California, twenty-two inches at San Francisco, seventy-eight inches at Astoria, Oregon, and nearly ninety inches at Sitka, in Alaska. The local surroundings of the last two places give them a rain-fall some twenty inches in excess of that exclusively due to the prevailing winds.

South of lat. 30°, where the N. E. trades prevail, and the atmospheric movements are from the land to the sea, districts are found which are almost rainless. It is doubtful whether artificial processes can ever materially change this condition. Tree-planting may increase precipitation where moisture-bearing winds prevail, which only require to be partially arrested and slightly cooled in order to deposit their moisture. But in districts such as those under consideration, the atmospheric currents being undercharged with moisture, all artificial aids to precipitation must prove futile, or at least but partially successful. The Viceroys of Egypt, during the first half of the present century, planted a large area with trees in the delta of the Nile and quadrupled the rain-fall of that district. But the prevailing wind of Egypt is from the Mediterranean sea, up the Nile, and the moisture intercepted is a part of that which was on its way to be precipitated on the mountains of Abyssinia.

Along the maritime districts, from San Francisco to Sitka, but little snow falls, except upon the coast ranges of mountain, the southerly winds and ocean currents keeping the temperature too high to permit its formation.

In the spring, when the southwest winds are succeeded by breezes from the west and northwest, the weather clears up and the dry season sets in and continues, interrupted by occasional showers, until early autumn. These summer showers are more frequent to the northward, and totally disappear south of lat. 42°. The dry season of the coast, and, indeed, also of the interior, is the result of two causes acting together. It has been stated that the summer winds are from the northwest. Coming from a small and cold ocean, where the process of evaporation is slow, these winds are cool and comparatively dry. As they move southwardly and inland, they receive a constant increase of temperature. It is a well-known fact that the capacity of atmospheric air to retain moisture increases with elevation of temperature. While, therefore, these breezes may distill occasional showers in more northern and cooler districts, as they move south and inland they become gradually heated, their capacity for moisture increased, and, instead of parting with any, they actually lap up what little surface moisture is found in their course.

A parallel instance is found in the constant northerly wind of the valley of Egypt, which, coming laden with moisture from the Mediterranean, fails to deposit it in the valley of the Nile, owing to the constant increase of temperature southward to Abyssinia, upon whose mountains it is eventually precipitated.

These N. W. winds deposit sufficient moisture along the maritime districts of British Columbia, Washington and Oregon to mature crops of all kinds—the late spring and early autumn showers rendering artificial irrigation unnecessary. In most parts of California, artificial processes have to be resorted to for the production of bulbous and tuberous roots, and indeed all classes of vegetation save the cereals, which mature before the dry season cuts them off.

East of the great Sierra Nevada and Cascade range, the N. W. winds of summer are partially excluded, and no moisture-bearing currents take their place for a period of from five to nine months, annually, according to the latitude. North of lat. 45°, the spring showers mature most of the crops and artificial irrigation is resorted to only for the gardens. South of that line irrigation becomes necessary for the production of any sort of vegetation, except along the low margin of streams which take their rise in the loftier mountain ranges and whose flow is made perennial by the melting snows.

It is probable that tree-planting may increase the amount of summer precipitation along the northerly portion of this vast interior region as far south as lat. 45°, but further south the heat is so great and the atmospheric currents so dry that it is doubtful whether forests, unless upon a scale of great magnitude, would reduce the temperature and improve the other conditions sufficient to cause precipitation. Indeed, it is equally doubtful whether tree-culture itself could be made successful except along the margins of the few feeble streams whose constantly diminishing waters are finally lost in the sands of the desert. To the candid mind, therefore, it appears almost certain that southeastern Oregon, southern Idaho, all of Nevada and Utah and a large portion of Colorado and Wyoming must remain as now, hot, arid and treeless wastes, covered with sand or incrusted with saline and alkaline matters, with occasional tracts of bunch grass and sage brush (artemisia), except in the isolated localities where irrigation is possible.

North of this region of desolation, through southern British America, Dakota, Montana, northern Idaho, Washington and northeastern Oregon, the solar heat is less intense, the earth contains less saline and alkaline matter, the surface is more diversified, forests frequently appear and experience has already demonstrated the existence of a climate adapted to all classes of vegetable life necessary for human subsistence. Still from the causes stated, large districts of country far to the north are dry and unsuitable for cultivation. These tracts however are clothed with bunch grass (the most nutritious of all grasses) and will afford "range" for innumerable herds of cattle and flocks of sheep. It is a common practice with teamsters, engaged in transporting military and other stores to the interior, to turn out their emaciated and exhausted cattle in autumn to seek their winter food as best they may upon these natural pastures. They invariably find these cattle in spring thoroughly recuperated, in good condition and well prepared for another season's labor—thus demonstrating the quality of the pasturage, and the additional important fact that the amount of snow deposited does not materially interfere with stock grazing. Concurring testimony may be found in the countless herds of buffalo that winter in these northern regions, even as high as lat. 54°.

In winter, the Sierra Nevada and Cascade range of mountains arrests the S. W. winds and, like an ice pitcher, condenses their moisture which falls upon its summits and slopes in the form of snow. The greatest depth of snow will be found where this atmospheric current is first and most completely arrested, which is along the loftier portions of the Sierra Nevada between lat. 34° and 42°. Hence, the name of these mountains—"Deep Snow Range." After the moisture-bearing winds have been bent from their course and deflected to the N. W., they deposit their moisture along the maritime districts principally in the form of rain. This will account for the diminution of snow northward. The upper stratum of the moist S. W. wind which escapes over the summit of the range is drier than the lower, and barely carries moisture sufficient to spread a thin coat of snow over the interior plateaus and a thicker coat upon the lofty peaks of the Rocky Mountain ranges.

A similar action of highlands upon moist atmospheric currents may be observed in Australia, where the mountain range which encircles the Continent at some distance from the coast, intercepts the wind, precipitates its moisture and makes an arid desert of the interior plateaus.

It is a remarkable fact that the snow, which never falls to any great depth upon the intra montane districts of our Continent, imperceptibly but steadily disappears, even during periods of severest frost. With the thermometer far below the freezing point, so that no melting can take place, the breezes seem to lap up the snow until the surface becomes entirely bare. This is probably attributable to the extremely dry atmosphere, which, in the coldest weather, with the aid of the solar rays, is constantly taking up moisture from the surface.

East of the Rocky mountains, and well to the northward, a new element enters into the climatic combination. The N. W. summer winds, which cross the Continent from the north Pacific and Behring sea, meet with but little obstruction in passing over the low and comparatively level districts of the north, until they reach the region of Saskatchewan, Assiniboine, eastern Dakota and Minnesota. Here they encounter, face to face, a portion of the N. E. trades from the Atlantic, which, as it enters the Caribbean sea, is deflected north by the lofty chain of the Andes, passes into the Gulf of Mexico, and thence northward up the Mississippi valley. Wherever these opposing atmospheric currents meet—the one cool and dry, the other warm and moist—copious precipitation must ensue. This meeting of the winds, and consequent summer rain-fall, take place in the region referred to and account for the anomalous fact that, in those districts, the summer precipitation exceeds that of winter.*

It will be perceived from the foregoing statements, that the belt of country from the Mississippi to the Pacific ocean, having the best climate, and consequent greatest fertility, lies between the 44th and 54th parallels of latitude. Without being too cold to develop the highest activities, it is more generously supplied with moisture than any portion of the country south of it. This is the great cereal-producing belt of the West, and experience has long since demonstrated that human beings gather in greatest numbers where food is most abundant and cheapest. The future must, therefore, witness the rapid settlement of the region in question, and its early occupancy by many millions of our race.

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* NOTE.—Those desirous of pursuing the subject of climate through the Mississippi Valley are referred to Professor Foster's "Mississippi Valley," published by S. C. Griggs & Co., Chicago, a most interesting book, and one which will repay a careful perusal.

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