air is always greater for some time after a rain because of increased surface evaporation.

COMPARATIVE CLIMATOLOGY.—Having sketched what climate is, and how it is primarily dependent upon solar radiation, modified by the agencies called in this connection climatic factors, we should next consider how we may best obtain a knowledge of the difference between the actual climates of the different regions of the earth's surface. The practice of classifying climates is an attempt at the solution of this difficult problem, for difficult problem it is, and will be so found by any one giving careful thought to the subject. Climates are classified variously. There is no definitely settled system, the deciding influence being that of the purposes the system is intended to subserve or illustrate. They may be classified with reference to their relative insolation, as solar or astronomical climates; or with reference to the general characteristics impressed on them by the two grand divisions of the earth, as land and water, or continental and marine, climates; or with reference to the possession in greater or less degree of some particular physical property, as heat, moisture, etc.; and finally, with regard to their physiological effects, as relaxing, invigorating, rigorous, severe, etc. The following schema will show in a measure some of the possibilities of climatic classification, and will suggest combinations that may perhaps be found more applicable to any particular purpose the reader may have in view:

Classification basis.	Subdivisions under classification.	General characteristics of each subdivision.
Solar or astronomical.	Tropical ...	Usually mild, equable, moist, warm, average temperature 80° F. Rainfall frequent and heavy over water and over windward land exposures. Nights usually clear, afternoons cloudy. No general storms. Seasons, rainy and dry; but this division is only a relative one.
	Temperate..	Unsettled weather, great and variable changes in temperature, rainfall, and moisture from season to season and day to day. Region of cyclonic storms, cold and hot waves, floods and droughts.
	Arctic......	Cold; temperature on average considerably below freezing. Scanty rainfall. Very short but hot summer. Winter long and severe. Storms infrequent.
Geographical.	Continental	High temperature in daytime, low at night. Difference between day and night temperatures increases toward centre of continent. Great variations in temperature, sometimes hot, sometimes cold. Moisture variable from almost saturation to aridity. Rainfall subject to great variations and extremes. General tendency to extremes in all climatic elements.
	Oceanic	Temperature equable, range between day and night hardly exceeds 2° to 4° F. in mid-ocean. Moisture high but constant. Rainfall frequent.
	Insular and littoral ...	Intermediate between above, partaking more or less of the characteristics of one or the other.
Topographical (land).	Plain.......	Extremes of temperature great, rainfall uncertain, humidity low.
	Hill	Extremes of temperature less than plain, rainfall greater, humidity higher.
	Mountain...	Generally same as hill, except effects of altitude become more evident; rainfall increases up to about five thousand feet, then decreases.
	Valley......	Extremes of temperature greater than hill. Humidity greater; rainfall greater than plain.
	Desert	Rainless; great extremes of temperature between night and day and season and season.
	Artificial ...	Such as climates of large cities. Temperature of cities always higher than surrounding country; haze and cloud and fog more frequent.
Aerophysical.	Temperature	High, Intermediate, Low — according to the degree of heat adopted as the standard of comparison.
	Humidity ..	Damp or moist, Intermediate, Dry or arid — according to standard of humidity adopted.
Physiological.	Invigorating......, Relaxing .., Rigorous, etc.......	According to the general effects of the particular climate.
	Mild ...., Pleasant ..., Humid....., Disagreeable, etc..	According to the general sensation produced, etc.

Exact physical measurements of the climatic elements and the effects of the climatic factors are essential to the scientific understanding and utilization of climate. How these elements and factors shall be measured and recorded is a question of the first moment, and one of the most difficult to formulate a satisfactory answer for. What would be a satisfactory determination of climate to the pure meteorologist would probably be unsatisfactory in a greater or less degree to the student of climate in its application to other subjects. The botanist, the zoologist, the physiologist, the sociologist, etc., each and all have a different view of climate, and each would measure it in terms not altogether applicable or best suited to the purposes of the others. To measure and record climate in a manner such that each inquirer would find what he looked for and in the shape in which it was wanted, would obviously be a task of magnitude. But, great as would be the undertaking, should any one desire to attempt it, a greater difficulty would be encountered in deciding what was suited to each interest. The discussion of this aspect of the question cannot be opened in this article. For the present, climate is for the most part measured and recorded as the student of meteorology conceives it serviceable and appropriate to the purposes of his science. Taking the climatic statistics as they are generally recorded, the question, however, becomes pertinent how to present them to the best possible advantage for the purposes of general information. Ordinarily these statistics are given in terms of their average values for a period of years. In some respects this kind of climatic information is useful and even indispensable; but it by no means conveys an adequate conception of the weather conditions that may prevail in the regions the statistics represent.

The method of averages, as is well known, smooths out, or masks, irregularities and extremes. The climate of a region is more important in respect to the extreme limits within which the values of its elements fluctuate than in the mean between these limits. The average temperature of two places may be the same, and yet, so far as the distribution of their temperatures either throughout the year or through shorter periods is concerned, they may differ to such an extent as to be unrecognizable when viewed in the light of the total effects of their respective temperatures. As concrete illustrations of this fact there may be cited the mean temperatures of two places in the United States each having the same yearly average of 49° F., viz.: Des Moines, Iowa, and Tatoosh Island, Washington. The average temperature of the warmest month at Des Moines is 75° F., at Tatoosh Island 56° F.; the averages of the coldest months are 18° F. and 41° F., respectively. The temperature at Des Moines has been observed as high as 104° F., at Tatoosh it has never been observed above 78° F. At Des Moines, the lowest recorded temperature was 30° F. below zero; at Tatoosh, 7° F. above zero. The total range of temperature observed, that is, the difference between the highest and lowest temperatures, was 134° F. at Des Moines, and but 85° F. at Tatoosh. Averages may thus be very misleading. Although the mean yearly temperatures of England and of New York are the same, Indian corn will not mature in the former, but does ripen readily in the latter, and all because the summer of England is cool and that of New York warm.

The following table compiled for the city of Washington, D. C., from the records of twenty-six years, 1871–96, shows what in the writer's opinion is a very concise method of presenting meteorological statistics for conveying a fair idea of the climate of a place: what kind of weather is ordinarily to be expected, and what kind of weather may occur:

WASHINGTON, D. C., RECORD OF TWENTY-SIX YEARS, 1871–96.

Climatic conditions.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Temperature (Fahr.)—												
Mean or normal	33°	36°	41°	53°	64°	72°	77°	74°	68°	57°	45°	36°
Normal maximum	41	44	50	63	75	83	86	84	78	66	53	44
" minimum	26	28	33	43	54	63	68	66	59	47	37	29
" variability *	6	7	6	5	4	4	3	3	4	5	5	6
Warmest month—												
Year	1890	1890	1878	1878	1880	1874	1876	1872	1881	1881	1896	1889
Degrees	44	43	49	58	70	78	81	79	77	63	51	46
Coldest month—												
Year	1893	1885	1885	1874	1883	1878	1891	1874	1871	1876	1880	1876
Degrees	25	27	34	48	59	69	72	72	62	51	40	26
Highest—												
Degrees	76	78	83	93	96	102	103	101	104	92	80	73
Day	12	23	22	18	26	9	18	13	7	3	13	4
Year	1890	1874	1894	1896	1880	1874	1887	1881	1881	1879	1879	1893
Lowest—												
Degrees	−14	−2	4	22	34	46	53	49	38	26	12	−13
Day	1	5	4	19	1	1, 6	20, 22	24	26	31	22	31
Year	1881	1886	1873	1875	1876	{1873} {1894}	1890	1890	1879	1893	1880	1880
Frost—												
Average date first killing frost (in autumn)—												
Day	....	....	....	....	....	....	....	....	....	22	....	....
Average date last killing frost (in spring)—												
Day	....	....	....	14	....	....	....	....	....	....	....	....
Humidity—												
Normal relative	77%	70%	66%	64%	69%	70%	71%	74%	76%	73%	72%	72%
" absolute, in grains per cu. ft.	1.6	1.7	1.9	2.9	4.4	6.1	6.7	6.5	4.5	3.4	2.4	1.8
Precipitation in inches—												
Average monthly	3.50	3.31	4.08	3.16	3.90	4.29	4.84	4.44	3.82	3.27	2.88	3.01
Average number days 0.01 inch or more	12	11	12	11	12	11	11	12	9	9	10	11
Greatest monthly—												
Year	1882	1884	1891	1889	1889	1883	1886	1875	1876	1885	1877	1878
Amount	7.09	6.84	8.84	9.13	10.69	8.55	10.63	12.93	10.81	8.69	7.18	4.94
Least monthly—												
Year	1872	1872	1894	1896	1875	1873	1872	1892	1884	1874	1890	1889
Amount	.23	.93	.98	1.07	1.01	1.63	.82	.85	.14	.29	.79	.19
Greatest amount in twenty-four hours—												
Amount	2.28	2.29	2.79	3.21	3.50	4.16	5.80	2.84	5.66	3.98	2.83	2.70
Day	4	5–6	9	26	7–8	22	29–30	29	15–16	4	24	17
Year	1886	1896	1881	1889	1886	1886	1878	1875	1874	1877	1877	1888
Greatest amount snowfall in twenty-four hours—												
Amount	5	10	6	4	....	....	....	....	....	†	2.5	10
Day	12	3	11	6	....	....	....	....	....	23	5	26
Year	1893	1886	1888	1889	....	....	....	....	....	1889	1891	1890
Weather—												
Average number of days—												
Clear	7	7	8	9	10	9	10	10	11	12	9	9
Partly cloudy	12	11	12	12	12	15	14	13	11	11	12	12
Cloudy	12	10	11	9	9	6	7	8	8	8	9	10
Wind—												
Prevailing	N. W.	N. W.	N. W.	N. W.	S.	S.	S.	S.	S.	S.	N. W.	N. W.
Normal velocity in miles per hour	6	6	8	8	6	6	5	5	5	6	6	6
Highest velocity—												
Miles per hour	46	60	48	43	54	48	60	53	66	51	54	49
From	N. W.	N. W.	N. W.	N. W.	S. W.	S.	N. W.	N.	S. E.	N. W.	S. W.	W.
Day	30	2	24	3	28	26	4, 28	5	29	4	23	9
Year	1894	1876	1878	1879	1896	1877	{1874} {1877}	1878	1896	1877	1891	1876

* Variability of temperature is the difference between the mean temperatures of consecutive days, irrespective of the direction of the change. Average variability shows how much one day is likely to be warmer or colder than the day before or the day after it. † Trace.

Of course for special purposes, special arrangements of statistics and special computations are required, but the above table has the advantage that it can be taken almost without additional calculation from the ordinary meteorological records of a first-order station or observatory. Uniformity in the publication of climatic statistics, as in all other kinds, is much to be desired. But such a table as the above does not give all that is desired for a complete conception of the climate of a place. The average and extreme values for seasons and for shorter periods is required. The average diurnal hourly values for each month are important items. The number of days with temperatures below and above certain definite degrees, the number of hours of bright sunshine, etc., are also matters of importance. In fact, the fullest conception of a climate can be had only by going into great detail and by looking at the values of the climatic elements in a variety of ways. In the study of individual climates, those of small areas can be pursued by the statistical method, of which the above table is an illustration. But for the study of general climates this method is too laborious, and the less accurate but easier method of graphic representation is used. In some respects graphic methods are more impressive and more readily grasped, and for this reason are much employed wherever the matter lends itself to such treatment. The preceding charts (Plate B).

showing the distribution of temperature over the surface of the earth in the months of January and July, are illustrations of graphic or chartographic methods. These charts show at a glance the effects of some of the disturbing and modifying influences concerned in bringing about the very complex distribution of climate on the earth's surface. The elevation of the January isotherms on the northwest coasts of America and Europe is strikingly evident. This is due to the westerly winds and ocean currents of these latitudes. The depression of the July isotherms in the same regions is due to the same causes. In the winter the waters of the North Pacific and the North Atlantic are warmer than the land, in the summer they are cooler; hence the winds blowing from them to the land carry the climatic conditions of the oceans to a greater or less extent inland.

Applied Climatology.—The relation of climate to the organic world is one of the most interesting and at the same time intricate of the problems that present themselves for scientific investigation. The relation of climate to the distribution of organic life has been discussed from time out of mind, but beyond a few generalizations little has been yet found out. That climate does control absolutely in some way the forms of life scattered with more or less appearance of regularity over the earth is a proposition that is generally admitted. It is the foundation stone of the modern theory of evolution. Indeed, it would be most difficult for any one to refute successfully the claims put forward in support of climatic control. However, it must be admitted that it is impossible at present to express the geographic distribution of the organic world in terms of functions of climate. Whether it will ever be possible to predicate with scientific precision the peculiarities of form, habits, and health that will be the necessary outcome of a given climate cannot be asserted at present either positively or negatively.

Climate and Man.—If the presence of man only be considered, it will be found that he exists in all known climates, from the equator to the poles, from the hottest to the coldest, in the dryest and in the dampest, and in equable and in variable climates. So far as ability to live is concerned, man appears, at first sight, to be independent of his climatic environment. Yet such is actually not the case. By intelligent foresight man is enabled to combat more or less successfully effects that would otherwise overcome him. Virtually he makes for himself an artificial climate. Deprived of the means of surrounding his person with this artificial climate, he would be restricted to very narrow geographic ranges. By the addition of clothing, he conserves his body temperature when his atmospheric surroundings would dissipate it too rapidly. He re-enforces when necessary the protection of his habiliments by refuge in dwellings and by aid of artificial heat, both of which his ingenuity has devised. On the other hand, when his climatic surroundings, or the weather, go to the opposite extreme he constructs fans and punkahs to create artificial breezes, and he brings ice that has been stored from the previous winter, or made by his refrigerating machines, to cool himself. If the region produce not the food that he requires, he transports it from where it can be obtained, and he varies the quality of that of his own locality by importation from abroad. Should the resources at his command prove insufficient for health and happiness he migrates to climates more to his liking. That he has not reached the poles, or scaled the highest mountains, is not because he can not abide the climates of either. He has mapped out plans that would accomplish these objects with certainty, but it requires the energy of more than a few hardy adventurers to carry them into execution. The human body has, however, a great natural tolerance for both heat and cold. Jacobabad, in India, is a city of 5,000 inhabitants, and its average July temperature is 96° F., but two degrees less than that of the human body. The United States Weather Bureau maintained from May to October, 1891, a station in Death Valley, Cal., and the observer, Mr. J. H. Clery, spent July and August in that place with mean monthly temperatures of 102° F. and 101° F. respectively. The inhabitants of Verkhoiansk, in Northern Siberia, endure a midwinter temperature of 60° F. below zero, or 92° below freezing. In ordinary winters of the temperate zones, quite frequently man passes suddenly from a warm room at 75° or 80° to the outdoors with maybe its temperature of zero or below. He lives in the deserts of Arabia and Africa, where clouds are seldom seen and rain more than once or twice a year is an unusual occurrence; and he flourishes in the tropical islands where rain and cloud are daily phenomena, and in the Khasia hills with their nearly five hundred inches of rain a year.

Different races are endowed with different degrees of climatic resistance. The Eskimoes, living in the cold and cheerless north, wrapped in skins, and huddled in ice dens as houses, find life outside of the Arctic circle almost unendurable. The Latin races of Europe live readily in the tropics where the Teutonic stock must struggle incessantly for existence. The Chinese may be found living easily from Manchuria to Australia. The Jew lives everywhere. He is as much at home in the climates of Siberia as in his native Palestine, and he is found from Cairo to the Cape. The Ethiopian can live in the hot jungles of the torrid zone, but finds it hard to flourish in the temperate climates of the northern United States. All this shows that it is not so much the climate as it is the man and the race. It is the personal equation of living after all, the habits and modes of life, that account for this varied tolerance. Climate places its imprint upon social life and customs, and long usage makes it hard to abandon them, even when reason and experience show their evil effects. The average Caucasian carries with him to the tropics the same habits of life, food, and drink, and even clothing, that he has acquired in the colder north, and then wonders at his inability to become acclimated in the torrid zone. In the deserts and on the great treeless plains where water and grass often fail, man becomes a nomad, driving his herds and flocks from place to place in search of sustenance. In the forest regions he fells trees and builds a cabin or a kraal, and lays the foundation of a permanent home. The character of the climate affects the habitation he erects for his use. Under the hot sun of the tropics his house is low and open, the shade is sought and every breeze courted. Farther northward the house grows higher and the openings are fewer and fewer. From wood and open construction it passes to brick and stone, and compact structure; and every device that promises to keep the outside climate out and the inside climate in is sought for. Still farther north, because it is hard to heat a large building in the intense cold of the Arctics, the house becomes smaller, and from the modern sky-scraper, with its furnaces, fans, and electric lights, and its other numerous conveniences, it descends to the small dugout, and the ice-cabin, wherein human beings huddle together for warmth from each other's bodies, the only sufficient source of heat at their command.

Climate leaves its impress even upon fiction and history, upon poetry and prose, religion and superstitions. To the wandering Bedouin, he who dug a well was a benefactor; paradoxically the well was the monument of a philanthropist. To die of thirst with water vanishing ere it touches the parched lips is the Arab's direst curse, and green trees and running waters his ideal of paradise. In the colder north, where the sufferings from cold and want of heat are felt, demons in red, with heated forks and fiery furnaces, terrorized the wicked and restrained the good, and the halls of Valhalla were the hope of a hereafter. Upon the features climate perhaps has an influence, but the periods required for many changes are relatively so great that we cannot measure them. Within historic times there is no evidence of ethnic change. The Ethiopian of to-day is the Ethiopian upon the bas-reliefs of Nineveh and Babylon. And the modern Egyptian fellah wandering about the streets of Cairo was depicted in the reign of the Pharaohs.

From the influence of climate on man's modes and life, it follows that directly or indirectly climate must exert a

profound influence upon his physical well-being. Abundant evidence of this influence is seen in the geographical distribution of certain diseases and their behavior when transported by commerce and migrations to other regions. Cholera and yellow fever are endemic within the sea-level altitudes of the tropics. Both occasionally are carried by agencies beyond their indigenous climates, and both after a greater or less time disappear completely from their new homes. The former lives longer out of its native habitat than the latter, which vanishes with the first air temperature of 32° or lower. Malaria is a widespread disease extending geographically on each side of the equator to the limits of the isotherm of 60°; beyond this it is not known to originate. Some forms of disease, as diphtheria, pneumonia, phthisis, rheumatism, nephritis, and others, show no definite climatic limits, and may apparently originate in any locality. Sunstroke, frost-bite, snow-blindness, and mountain sickness are perhaps the only ones that can be said to be caused by the climatic conditions under which they develop. The most important influence of climate is that which it sustains as a predisposing agent. The manner in which this influence may be exerted will depend upon the nature of the disease.

Modern research warrants the classification of disease into two general categories, viz., infectious and non-infectious; the germ diseases and the non-germ diseases. Of the first class, obviously those diseases that result from the presence of the strictly obligate parasites can be affected solely through the medium of the host; and so we find the diseases from such germs everywhere that the diseased host may migrate and live. Among this class are rabies, syphilis, and gonorrhœa. Upon the exciting causes of these diseases climate has no opportunity to act directly. Upon obligate parasites, but those of greater resistance, and which may exist for some time outside of the animal body, but which probably do not lead a saprophytic existence, there is opportunity for climatic effect. To this class belong the germs of diphtheria, glanders, variola, measles, and scarlatina. And there is some reason for supposing that the variations in virulence manifested in the different epidemics of these diseases are partly due to such causes. Upon the facultative saprophytes and the facultative parasites there is abundant opportunity for the effects of meteorological agencies. Under one or the other of these classes are the germs of phthisis, anthrax, typhoid, cholera, tetanus, yellow fever, and the various pyogenetic microbes. And, again, the evidence of variation in malignancy of these diseases can be accounted for, at present at least, only on the supposition of some favorable or unfavorable meteorological influences. Further corroboration of the probability of such suppositions is furnished in the experiments that have been made by different observers on the attenuation of microbic virulence when the micro-organisms were grown under certain physical conditions of temperature, humidity, and illumination. The effect upon the different pathogenetic micro-organisms is particularly noticeable in respect to sunlight. Moist bacilli and spores of anthrax are killed by two hours' direct exposure to the sunlight. Koch states that a few minutes in the sunlight will kill tubercle bacilli, and diffuse sunlight will kill them in from six to seven days. Sawisky found that they gradually lost their virulence in from two and a half to three months in ordinarily lighted dwelling houses. Two hours' insolation is sufficient to kill typhoid bacilli. A few hours' drying will kill the comma bacillus of cholera. None of the pathogenetic parasites multiply under temperatures below 50° F.

Experiments have shown that physical environment can profoundly alter the resistance of the host to infection. Hens will not contract anthrax unless they be first chilled by exposure to the cold. Frogs become susceptible to the disease if kept in an atmosphere of 80° F. or more. Bowditch in this country and Buchanan independently, in England, showed that soil dampness favored the development of tuberculosis. The relation of the ground water and its fluctuations to typhoid has been widely discussed, and the maximum prevalence of the disease after the hot weather of summer has suggested a lowered resistance in the human body. The general prevalence of pneumonia in winter, and its relatively great frequency in climates of high altitudes, have pointed to a meteorological predisposition. As has been mentioned previously, the absolute atmospheric humidity is controlled by the temperature. A cubic foot of air at 32° F. can contain at the most but 2.1 grains of moisture; at 98° F. it can contain 18.7 grains. A cubic foot of air inspired at 32° F. or below, is warmed up in the respiratory passages to about 98°, and is expired saturated with moisture, and it takes from these passages 16.6 grains of water. If this moisture be not supplied rapidly enough by the naso-bronchial mucous membrane, dryness and mechanical irritation result, and this may be the sufficient predisposition for the graver disease, the preparation of the soil for the germ. Excessive evaporation from the respiratory passages is a fact both in cold weather and in elevated regions, and pneumonias are then and there prevalent. Longstaff found that diarrhœal diseases became epidemic in London when the water of the Thames reached 62° F., and Ballard, looking in another direction, found them epidemic when the temperature of the ground four feet below the surface rose for the season to 56° F.

The treatment of disease by climate forms an interesting and important chapter in medical literature. The particular manner and the properties of climate that effect the cures are still subjects of medical polemics. The chief disease that climate is relied upon for curing, to the exclusion of almost all else, is phthisis. That change of climate in this disease is beneficial would be folly to attempt to gainsay. The present consensus of medical opinion leans to the climates of altitude, particularly those above three thousand feet elevation. Altitude, moderate temperatures, clear skies, and well-drained soil appear to be the climatic desiderata for this disease. In this malady the physiological effects of high altitude have usually been considered as the most efficient therapeutic properties of the climate.

The present writer, from a careful consideration of the known physiological actions of the different climatic elements and factors, takes exception to the claims of altitude in this disease. Without entering into any discussion he ventures to state that whatever virtue there is in such widely recognized climates as Colorado, the Engadine Alps, and others as sanitaria for phthisis flows from the absence of clouds and is due to the effects of the intense insolation under low atmospheric temperatures that favor life passed in the direct sunlight rather than in the shade.

The utilization and indications for climate in diseases belong rather to the therapeutics of each disease than to the present article, which is but a brief attempt to define climate and point out the general principles that will indicate what climates are to be expected in given localities, or, a particular kind of climate being given, where it can be most nearly approximated. In climatotherapy, however, one should bear in mind, as a motto, the dictum of Scoresby-Jackson: "If it be a good thing for a sick man to change his residence, it must be a proper thing for him to know what it is that he is avoiding, and what it is that he is to acquire in exchange for it in another place." The what-it-is-that-is-to-be-avoided and the what-acquired must be worked out by the physiologist, pathologist, and the therapeutist much more thoroughly than at present before climato-therapy can become other than empiricism.

Climate and Animals.—Endued with only a limited degree of reasoning ability, but few animals evince any intelligent foresight in providing against future contingencies of heat, cold, famine, or drought. The nearest approach to prevision is exhibited in the migratory and the hibernating habits of some animals, and in the storage of food by a few others. The climatic control of the distribution of animals is perhaps as much one of indirection as of direction. Cats cannot live at an elevation of eleven thousand feet, and all efforts to introduce the Newfoundland dog in India have failed. The polar bear cannot live outside of the isotherm of 32° F., unless surrounded with an artificial reproduction of its native climate. On the other hand, many natives of the tropics find no difficulty in living in the colder temperate zones. Parrots introduced into England flourish in the woods of Norfolk, and that they have not spread over the island is more a matter of food supply than of inimical climatic conditions. The tiger stands the jungle climates of Bengal and the snows of Thibet with equal impunity. The elephant, found now only in the tropics, once roamed over the table-lands of Siberia. The matter of food supply and the ease with which food can be obtained are more influential than the direct physiological effects of the climate itself.

Adaptation to climatic conditions is seen in many animals. The change of color and of thickness of the pelage with the change of seasons is a physiological tribute to climate. The peculiar body formation of many animals is an accommodation to the direct influence of climate. The arboreal animals are unfitted for the treeless prairie. The camel is found in the desert, but it would perish in the forest. Sheep and goats are adapted to the climate of mountains, but not to that of forests. In each and every case we shall find an effort at accommodation in one way or another to climatic environment, and in most of the cases the adaptation is one rather to the food supply, and ultimately to the vegetation of the climate, than to the immediate physiological effects of the meteorological environment.

The key to climatic control of the distribution of animals is in the struggle for food. Many of the extinct animals disappeared not from any secular change of climate, but simply from the advent, often perhaps accidental, of some other form that preyed upon it or its food supply. Goats introduced into the island of St. Helena destroyed a whole flora of trees, and with it doubtless disappeared many if not all of the parasites dependent upon it. Swine introduced in Mauritius destroyed the dodo. The mongoose in Jamaica has completely exterminated the native fauna of this island.

Climate and Vegetation.—The character and distribution of vegetation are both distinctively climatic results. Light, heat, and moisture, in greater or less degrees, are essential to the development of vegetable life. The measures in which these elements are combined determine the general characteristic features of the vegetation. Variations of degree in these characteristics result from the combination of the effects of climate and those of other factors, as the structure and composition of the soil, the effects of animal life, etc. The intense heat and generally abundant moisture of the tropics favor a luxuriant growth in forms that in colder regions are diminutive in size. The vegetation of arid regions is distinct from that of humid countries; and the vegetation of the hot deserts is different from that of the deserts of colder latitudes. Under the equator palms and bananas are the typical forms; then, receding toward the poles, come in succession tree ferns and figs, myrtles and laurels, evergreens, deciduous trees, conifers, lichens and dwarf shrubs, and mosses. If we ascend a high tropical mountain we shall find the same change of vegetational formation.

The following tabular view will present the approximate general distribution of vegetational types with reference to the average temperature under which each best develops.

Zone of—	Average temperature of zone.	Altitude of each under the equator.
Palms, Bananas	82°–70° F.	At sea level.
Tree ferns, Figs	78 –73	From sea level to 2,000 feet.
Myrtles, Laurels	73 –68	From 2,000 to 4,000 feet.
Evergreens	68 –60	From 4,000 to 6,000.
Deciduous Trees	60 –48	From 6,000 to 8,000 feet.
Conifers (pines, etc)	48 –40	From 8,000 to 10,000 feet.
Lichens, Mosses	40 –32	From 10,000 to 12,000 feet.
	32° and lower.	From 12,000 to 14,000 feet.

The distribution of the temperature and the rainfall are the most important factors in vegetation. And it is the heat of the summer rather than the cold of winter that determines the limit of vegetation. A broad generalization has been made to the effect that the geographical distribution of animals is dependent upon that of the minimum temperatures of winter, and the geographical distribution of the different varieties of plants is dependent upon the maximum temperatures of summer. Observation of the lowest temperatures at which most plants begin to germinate shows that vital action is not evident till the temperature rises to 43° F. This is the first effective temperature. Plant growth takes place only so long as the temperature is at or above this point, and the amount of growth that actually takes place, other conditions being favorable, is estimated by the product of the number of hours by the number of degrees the temperature is above 42° F. This product is called the accumulated temperature, and represents the total effective temperature for plant development. The higher the temperature, up to a certain optimum, varying for different plants, the greater the rate of growth. The study of plant growth and meteorology is receiving the scientific attention that it so well merits. When more progress has been made scientific phenology will be a most important and valuable assistance to mankind.

W. F. R. Phillips.

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CLIMAX SPRINGS.—Camden County, Missouri.

Post-Office.—Climax. Hotel.

Access.—Viâ Missouri Pacific Railroad to Warsaw, thence 25 miles by stage to springs.

These springs are seven in number, and are located in a rolling, heavily timbered region, with many pleasing landscapes. An analysis of the waters was made in 1882 by Prof. N. W. Wiley, of Purdue University, Indiana, State Chemist.

One United States Gallon Contains:

Solids.	Grains.
Calcium oxide	4.98
Magnesium oxide	1.80
Aluminum oxide (with iron oxide)	5.08
Sulphuric acid	3.60
Carbonic acid	3.92
Sodium	14.00
Potassium	1.20
Iodine, Bromine	14.00
Chlorine	20.40
Loss	3.02
Total	72.00

The waters are remarkable for the quantity of iodine and bromine which they contain. They are somewhat similar to the waters of the celebrated Kreutznach Springs, of Prussia, but are far stronger in these ingredients. Such waters are especially adapted for the treatment of chronic syphilitic and scrofulous affections.

The analysis is obviously incomplete, however, and a new examination should be made. We have been unable to obtain a recent report of these springs. The foregoing account is compiled from Walton's work and from the United States Geological Reports.

James K. Crook.

CLOVER, RED.—The flower heads of *Trifolium pratense* L. (fam. *Leguminosæ*). The herbage of most of the two or three hundred species of *Trifolium* is rich in albuminous nutriment, or *legumin*, and red clover is one of the best and the most extensively cultivated of these fodders. During recent years it has come into prominence as an ingredient of a "shotgun" preparation, used as an alterative of which the other ingredients represent the activity. *Henry H. Rusby.*

CLOVER, SWEET. MELILOT.—The dried herb of two species of *Melilotus, M. officinalis* Desr. and *M. altissimus* Thuill. (fam. *Leguminosæ*). These are tall, upright, or straggling biennial herbs, with small trifoliolate leaves and axillary spikes of minute clover-like flowers. Both plants are fragrant, having the pleasant odor of Tonka beans, which is also increased by drying. They contain also the same odorous substance found in Tonka beans, *cumarin* (cumaric anhydride), as well as the related substances, *melilotus oil, melilotic acid,* and *cumaric acid.*

Melilot is a mild and pleasant aromatic of no special value in medicine, and is fairly obsolete. The infusion was formerly employed to a considerable extent as an eyewash. Dose indefinite. *W. P. Bolles.*

CLOVERDALE LITHIA SPRINGS.—Cumberland County, Penn.

Post-Office.—Newville.

This artesian mineral-water fountain is located 2½ miles northwest of Newville and 5 miles south of the Doubling Gap White Sulphur Springs. It was discovered in 1865 by a party prospecting for oil. The opening bored through the solid rock to a great depth struck this water vein, which, being released from its subterranean confinement, gushed to the surface at the rate of three hundred gallons per hour under the pressure of its own carbonic acid gas. The flow since that time has never diminished, being uniform at all seasons of the year. The water is perfectly clear and entirely free of organic matter, and has a temperature at the spring of 52° F. The following analysis was made in 1889 by Prof. E. T. Fristoe, of the Columbian University, Washington, D. C.

One United States Gallon Contains:

Solids.	Grains.
Potassium carbonate	0.20
Lithium carbonate	0.17
Magnesium sulphate	1.60
Magnesium chloride	0.09
Sodium chloride	Trace.
Magnesium bicarbonate	0.42
Calcium bicarbonate	6.67
Iron oxide and alumina	0.75
Silica	0.80
Phosphoric acid	Trace.
Total	10.70
Gases.	**Cubic inches.**
Carbonic acid	1.070
Oxygen	1.109
Nitrogen	6.013

This water is not heavily impregnated with mineral ingredients, yet when taken in sufficient quantities it exerts an undoubted influence on the physical economy. It has been found to possess antacid, mild aperient, and tonic effects. Its clear and sparkling appearance and freedom from organic impurities qualify it for table and domestic purposes. It is said to have been found fresh and palatable after three years' bottling. The water is used commercially. *James K. Crook.*

CLOVES.—*Caryophyllus,* U. S. P.; *Caryophyllum,* B. P. "The unexpanded flowers of *Eugenia aromatica* Linn." (U. S. P.). "The dried flower buds of *Eugenia caryophyllata* Thumb." (B. P.). This tree, to which each pharmacopœia has given a different name, is a member of the order *Myrtaceæ,* in which are included many aromatic plants such as the allspice, bay, cajuput, and eucalyptus. It is a beautiful, fragrant, evergreen tree, with a fine pyramidal crown thirty or forty feet high, and with bright crimson flowers. The branches are numerous, slender, horizontal, the leaves opposite, lanceolate, pointed, entire, dark green and shining, and covered with glandular dots. Flowers in terminal clusters, articulated. Calyx brilliant crimson, with a long, solid, flattened, cylindrical tube (receptacle of Baillon), in the

Fig. 1386.—Clove Tree, flowering branch one-third natural size. (Baillon.)

upper part of which the minute ovary is embedded, and four thick, spreading, triangular lobes. Petals also four, cream-colored, orbicular, arched, in the bud imbricated in a perfect globular head; stamens very numerous, ovary minute, two-celled, many-ovuled, embedded in the fleshy calyx mass; style slender, single. Fruit oval, crowned with the four conniving calyx teeth, one-seeded (the mother cloves of the market). Length of flower about 1.5 cm. (½ in.), of fruit about 2.5 cm. (1 in.).

Its orginal habitat was the Molucca and Philippine Islands, but it is now cultivated in the islands of the Indian ocean, Southern India, Africa, the West Indies, and South America. The buds are collected just before the petals expand and the process requires much care and experience. If gathered too soon, the clove is deficient in its aromatic constituents; if too late, the corolla expands when drying. The buds are dried in the sun, and much attention is given to procure the characteristic rich brown color. All parts of the plant are aromatic, and the small branches are often broken into small pieces and colored for the purpose of adulteration. Ground cloves often are made up of a large proportion of the branches and also of the fruit. Another adulteration of ground cloves is the addition of cloves from which the oil has been abstracted. The clove somewhat resembles a nail in shape, its name being derived from the French *clou.* "It is over half an inch long, dark brown, consisting of a sub-cylindrical, solid, and glandular calyx tube, terminated by four teeth, and surmounted by a globular head, formed by four petals, which cover numerous curved stamens and one style. Cloves emit oil when scratched, and have a strong aromatic odor, and a pungent, spicy taste" (U. S. P.). Cloves contain a large percentage of the official oil, which forms as much as one-fifth of its bulk. There are also present tannin, gum, resin, etc.; *caryophyllin,* $C_{20}H_{32}O_2$, which is isomeric with camphor; and *euginin,* none of which are of any therapeutic