Geography, physical, economic, regional

James Franklin Chamberlain

LIPPINCOTT'S SCHOOL TEXT SERIES

EDITED BY WILLIAM F. RUSSELL, PH.D.

DEAN, COLLEGE OF EDUCATION, STATE UNIVERSITY OF IOWA

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210 ILLUSTRATIONS

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PREFACE

To prepare the youth of our land to be self-supporting, to intelligently participate in local and national affairs and to be useful and honored members of society, are among the great aims of education.

The World War stimulated the reconstruction of our educational scheme, and in all parts of this country efforts are being made so to recast our courses of study that school-education may be of greater value in the affairs of life.

In this work the secondary schools are being carefully studied. This is very important because comparatively few of our young people extend their school life beyond the high school. This means that the studies selected for this four-year period should be chosen because of their actual value to the average individual, rather than because they prepare a few students to enter college.

That the future history of our country is to be inseparably connected with that of the rest of the world is now an assured fact. No longer can our national life be one of isolation, even if we so desired. To perform efficiently and justly our part in world and national affairs, we must know geography.

It is generally conceded that geography is one of the broadest of subjects, and that it cannot, in its deeper significance, be grasped by pupils in the elementary schools. This means that geography should be taught in every secondary school, and in every institution of higher learning in the United States.

The great need is for a fuller grasp of physical and economic geography and the regional geography of our own country. The report made by the National Education Committee in 1908 emphasized this, as did the report made in the same year by the Committee of the Association of American Geographers.

In the present volume physical geography is presented as the necessary foundation. The work is fully humanized and many points which are presented in the ordinary course in physical geography are here omitted. The student is led to study geographic forms and processes, not as things and conditions apart from human affairs but rather in their relations to the life of man.

Economic geography is presented because of its very practical value to men and women in every walk of life. A comprehensive view of industrial and commercial conditions as applied to the world is given. Many figures are of necessity employed, but as those relating to a given year are usually of little value as applied to any other year, the author has, for the most part, used five- or ten-year averages. These vary but little from year to year. Some of the averages close with the year 1913, in part because conditions became very abnormal after that date and in part because of the impossibility of securing accurate information applying to certain countries during the war period. The figures of the Fourteenth Census, in so far as they are available, have been used.

A somewhat intensive study of the geography of the United States is of the utmost importance. How superficial is the knowledge of our country possessed by the average person is well known. As to the natural regions into which the United States should be divided, there is some difference of opinion. The regions here used are as satisfactory and as helpful as any in bringing about the desired result.

Many persons have assisted in the preparation of this volume, to all of whom I am very grateful. I am especially indebted to Mrs. Kathleen Beck, Instructor in Geography in the University of California, Southern Branch, who read the entire manuscript and prepared most of the drawings. Miss Ruth E. Baugh, Instructor in Geography, Dr. Fred A. Howe, Assistant Professor of English, and Dr. Ford A. Carpenter, Lecturer in Meteorology, all of the above named institution, rendered valuable service. My brother, Arthur H. Chamberlain, Secretary of the California Council of Education, furnished many very helpful suggestions. To those who have kindly supplied pictures, credit is elsewhere given.

JAMES FRANKLIN CHAMBERLAIN.

December, 1920.

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CHAPTER I

Man and His Physical Environment

Man and Climate.—The average citizen of the Sahara cannot be reached by mail, telegraph nor telephone. Neither train, trolley, auto nor carriage will carry one to his residence. His home is one of a collection of similar buildings hidden by groves of date palms, among which narrow paths wind, and small streams of water flow. Outside the groves there are fields of barley and wheat, and gardens where vegetables and fruits are grown.

The houses are in most cases constructed of stones, sun-dried bricks or skins, making homes which are usually dark, poorly ventilated and uninviting. There is little furniture. Cooking is generally done over an open fire, and the smoke escapes as best it can. If a drink of water is desired, it is obtained from a nearby well or from a spring instead of from a faucet.

When a Saharan wishes to make a journey he mounts a camel, and in company with others similarly mounted, rides away. At once he passes from the shade of the date palms to the glare of the desert. Day after day and week after week the sunshine beats down on the almost waterless wastes of sand and rock. The earth is hot to the touch. The wind shifts the sand dunes as it does snow drifts in cold regions, and at times drives the sand grains against the hands and face with cutting force. The glare of the sunlight is painful, and the eye longs for the restful green of vegetation. In a journey of hundreds of miles neither lake, stream, forest nor meadow might be seen. Except on the occasional oasis there is no tilled land, for only in such a situation is water to be found.

In most parts of the Sahara the average annual rainfall is less than 10 inches, and in many places it is practically nothing. Where mountains rise high enough to chill the atmosphere to the condensation point, there is some rainfall. Obviously the Sahara can support but a small population, and this is distributed in accordance with the water supply.

Upon some of the oases there are towns of considerable size. Caravan routes connect the towns, the chief business of which is the trade in dates. As the camel can live for several days without water and with very little food, it is the chief means of travel and of transportation. Absence of timber explains why the houses are usually constructed of stones, sun-dried bricks or skins. The high tem-

FIG. 1.—A Sahara Desert Scene. The Mohammedan driver hobbles the animal's foot while at prayer.

perature and abundant sunshine make it possible to grow the date, and the date industry is therefore the chief occupation of the people. Lack of means of easy communication with the outside world, as well as the poverty of many of the people, have resulted in the retention of primitive ways of living.

The one condition which more than any other restricts settlement and influences the lives of the people on the Sahara is climate, or to be more exact, the lack of rainfall. Most of the soil is fertile, but except in favored localities Nature withholds the rain without which the earth cannot yield her fruits. Similar conditions of climate and of life exist in much of Arabia and Australia, and in smaller areas in many lands.

Greenland differs from the Sahara in being a cold desert. The people are isolated, and their lives are strikingly dominated by Nature. With the exception of a narrow coastal strip, the land is covered with snow and ice at all seasons of the year. This makes agriculture impossible. The food of the native inhabitants, except those who come in contact with white men, is therefore obtained from the animals which live upon the island and in the surrounding waters. The climatic conditions render forests impossible. As a result, the dwellings are constructed of the most available materials—snow and ice in the winter, and skins in the summer.

The Eskimos who live near the coast, and who therefore carry on a trade with the white men, secure clothing and other articles from them. The people who live in the interior are dressed in the furs and skins of animals. Native tools are made from bones and stones, and hollowed-out rocks, in which the oil of the seal or walrus is burned, serve as lamps and stoves.

Railroads are unknown, and as the country affords no pasturage, there are no horses or cattle. The dog, which can subsist upon a meat diet, furnishes the only means of transportation by land, other than walking. Although the area of Greenland is about the same as the combined areas of all of the states east of the Mississippi river, the total population is less than 20,000.

The physical environment of the Eskimo makes a diversity of occupation impossible. There is practically no such thing as a division of labor, and therefore none of the industrial problems so important in most parts of the world. House and boat building, hunting, fishing, tailoring, and the manufacture of a few crude articles are carried on by each family.

There are great land areas surrounding each pole, and there are smaller areas at high altitudes in many parts of the world, where there is little or no human life. As in the Sahara, it is climate which accounts for the sparse population, but the controlling factor is low temperature rather than lack of precipitation.

In the humid parts of the tropical zone Nature is so lavish that man does not need to struggle to secure a living. Wild and cultivated products of the soil furnish an abundance of food. Because of the high temperature, the requirements as to clothing and shelter are limited, and again the needs are met by the immediate environment. As vegetation grows at all seasons there is no period for which pro-

FIG. 2.—A scene in polar regions. Peary's ship "Roosevelt" icebound.

vision must be made in advance. These conditions do not develop thrift; in fact a hot and humid climate tends to foster indolence. This is illustrated on the delta of the Ganges, on the lowland areas of the Philippine Islands, in the East and West Indies, on the Atlantic coastal plain of Mexico and in other similar situations.

The climatic conditions which are most encouraging to progress exist in the middle portions of the temperate zones. In these areas there is a long period during which vegetation does not grow. As a result of this, man must each year accumulate a surplus of the necessities of life in order that his needs may be met during the cold season. Through the exercise of reasonable foresight and energy some leisure is available. As a moderately cold climate acts as a tonic, the leisure is used to advantage, and as a result, we have under these climatic conditions the most rapid human progress.

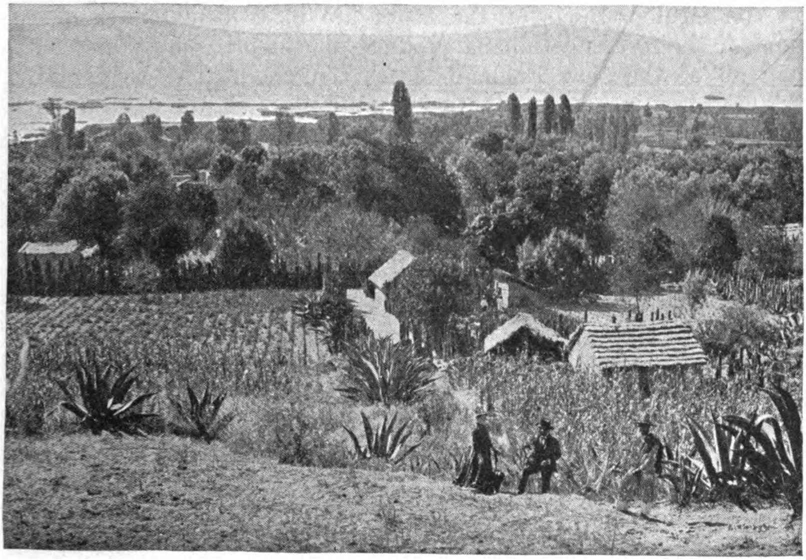


FIG. 3.—A tropical scene.

In some areas climate exerts a special influence during a part of the year. Northern Italy, the southeastern coast of France, Florida and California attract large numbers of winter residents. Favorable summer climate is an important reason why Switzerland, the White Mountains, the Berkshire Hills and Adirondacks have large populations at that season. In the sections mentioned, there are cities and towns the interests of which are very largely based upon the tourist business.

No other physical condition exerts so great an influence upon human affairs as does climate. There is the most vital relationship between climate and the products of the soil. Directly or indirectly man depends upon plants for his food, clothing, and a large number of other things. We can in a measure control many of the forms and the forces of nature, but it is not within our power to modify climate.

Man and Topography.—Topography exercises a powerful influence in promoting or retarding the industrial and commercial development of a region. Surface features, by their ruggedness, often make the extensive development of agriculture, the basal industry, impossible. There are many illustrations of this. The combined area of the New England states is nearly twice that of the state of Indiana, yet the farm products of the latter are more valuable than are those of the former. Indiana produces more corn, wheat and oats than all of the New England states combined. The topography of West Virginia, eastern Kentucky and Tennessee, the western part of the Carolinas, northern Georgia and Alabama discourages extensive agriculture. Norway is essentially a land of mountains, and as a result less than five per cent. of her area is cultivated. Japan is for the most part a mountainous land, where we find only about ten per cent. of the area tilled. In Switzerland and in parts of Austria, agriculture is carried on under great difficulties because of the broken surface. Along the Rhine the steep hills are terraced and covered with vineyards. A rugged topography also has the effect of lessening the machinery employed on the farm.

The states in the central part of our country have a topography highly favorable to the development of agriculture. This has had its effect in causing this section to become the granary of the United States. Russia, partly because of the levelness of surface, is essentially an agricultural country. More than three-fourths of her people live in the country, and her exports are very largely the products of the soil. France, with her long plain sloping gently to the westward, has fifty-five per cent. of her total area under cultivation. Hungary, Argentina, the great plains of China, and the plains of India are very largely agricultural.

Although the surface of New England is unfavorable to farming it promotes manufacturing. The steep slopes, as well as the glacier-filled valleys, have given rise to swift streams. These, even in early days, were turned to account in the sawing of lumber, the grinding of grist, and the manufacture of cotton. The Merrimac, although a stream of inconsiderable size, produces a vast amount of power. On this river we find the manufacturing centers of Haverhill, Lawrence, Lowell, Nashua, Manchester and Concord. Electric energy in the form of both light and power is also extensively developed in New England, at Niagara Falls, in our southern uplands, at Keokuk, Iowa, and on the Pacific Coast.

Because of great relief and abundant precipitation Norway, Sweden and Switzerland are richly endowed with water power. It has been estimated that from the streams of Norway 5,500,000 horse power can be developed. Norway is using a large amount of hydro-electric energy in the fixation of nitrogen.

From the streams of Switzerland it is possible to develop about 2,000,000 horse power. More than twenty-five per cent. of this amount is being utilized. During the summer the streams are in full flood because of the melting of the snows and glaciers. Much power is used in operating mountain railways.

The World War stimulated the development of water power in European countries. In the neighborhood of Grenoble, France, there is much activity along this line. The same is true of Barcelona, Spain, and of the Piedmont section of Italy. Although Great Britain is so rich in coal, increased attention is being given to the development of water power.

A mountainous surface restricts trade and travel because it increases the cost of road building and operation. In rugged areas roads follow the river valleys, and passes play an important part in guiding routes. In addition to the great lift, there is the cost of rock blasting, tunneling, and the construction of many bridges. Sharp curves help to reduce the running time, and this means added cost.

The Pyrenees rise along the boundary between Spain and France to the maximum height of 11,000 feet. So effectually do these mountains act as a barrier to commerce between these nations that no railroad crosses them. The only railroads connecting Spain and France were built around the east and west ends of the mountains. At the present time (1920) there are three lines under construction each of which will cross the Pyrenees.

The republic of Switzerland, surrounded by mountains, was at a great disadvantage both industrially and commercially until the tunnels connecting it with other countries were built. The St. Gothard tunnel, nine and a half miles in length, affords a ready means of connecting Switzerland with Italy. By means of this passageway through the lofty mountain wall, raw silk and other commodities are brought in from Italy and converted into finished products. The Simplon tunnel places Switzerland in connection with Paris and France by the way of the Rhône valley and the "Burgundy gate."

The Engleburg tunnel puts Switzerland in connection with the great city of Vienna to the advantage of both.

The Himalayas, the most lofty mountain barrier on the face of the earth, rise on the north of India. Here Mt. Everest lifts his head crowned with everlasting snows to a height of 29,000 feet, and there are many other peaks in the vicinity more than 20,000 feet in altitude. The average height of the passes is greater than that of most peaks in the Rocky Mountains and they are generally occupied by great glaciers. No railroad connects India's 300,000,000 inhabitants with

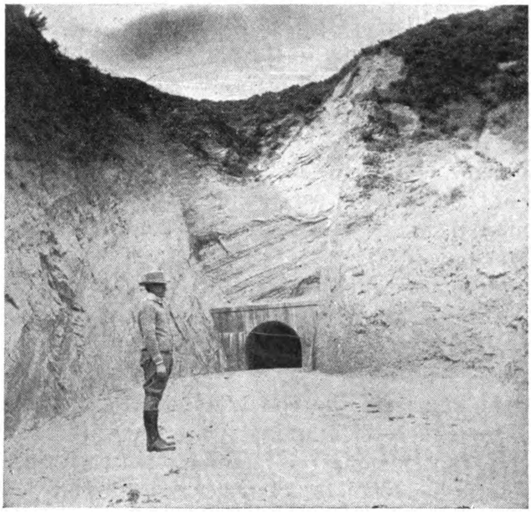


Photo by Grace Auderegg.

FIG. 4.—Entrance to a tunnel.

the vast Chinese Republic lying to the northeast. No wagon roads are built over the "abode of snow." With the greatest difficulty yaks and porters toil up the mountain sides and over the glacier-filled passes, thus making possible a very inconsiderable trade by land between the two most populous nations of the earth.

In mountainous regions the influence of topography upon the *direction* which trade and communication take, as well as upon their *extent*, is marked. In the central part of our country, roads of all kinds are built with little regard to the topography. In the more rugged sections of the United States lines of travel almost invariably follow the valleys. A study of topographic maps representing level and mountainous areas will bring out these points.

On the other hand, if a mountainous country has attractive scenery or great mineral wealth, it develops transportation facilities. The wonderful scenery of Switzerland has led to the building of carriage roads and railroads, and to the erection of many hotels. Auto roads are being made in all of the scenic parts of our country in order to make their beauties easily accessible.

It is upon the plains that the dense populations of the world are generally found. In these situations, as has been stated, levelness favors agriculture, and travel and transportation. The soil is usually deep and fertile, being in large part the result of long-continued waste of higher levels. Streams, in many cases, afford cheap transportation for people and products, as well as water for irrigation. In temperate latitudes the most desirable climatic conditions exist upon the lowlands. The plains of China, western Europe, Argentina, and our Atlantic Coastal Plain are illustrations.

Man and the Soil.—Directly and indirectly climate is the chief factor influencing agriculture. As has been shown, topography also exercises a strong control. The density of rural populations, the value of the land, the character and value of the crop, the roads, and social development generally, bear a definite relationship to the nature of the soil.

As a rule soils are productive where favorable climatic conditions obtain. In some areas soils are deficient in some important element or contain something injurious to most crops, as alkali. The nature of the soil, if residual, depends upon the underlying rock. A soil composed of disintegrated limestone is usually more fertile than one composed of decayed sandstone. This is because the former as a rule contains more mineral plant food than does the latter. Lime increases the ability of the soil to hold water and it prevents souring of the soil. Whitbeck[1] has shown that in Wisconsin farm values are greater in the areas of limestone soils than in those of sandstone soils. This is true in Kentucky, in the Gulf Plains, and elsewhere.

From New Jersey to Georgia the seaward portion of the Atlantic Coastal Plain is, as a rule, marshy or composed of a light sandy soil. In this area farm values are less than they are in the section to the westward. In more than a dozen counties along the coast of Georgia the value of the farm land was in 1910 less than $10 per acre. In the section immediately adjacent, values ranged from $10 to $25 per acre.

[1] Whitbeck, Ray Hughes: "The Geography and Industries of Wisconsin," pp. 37, 38.

The soils of southeastern Illinois are not nearly so fertile as are those of the central part of the state. In the central part the soil is deep, loose, well-drained and highly fertile. In this section the value of the farm land ranged from $100 to $125 per acre, but in the southeastern part the value was from $25 to $50 per acre in 1910.

The best agricultural section of England is the southeastern part. There the soil is deep and fertile, formed by the decay of calcareous rocks. Agriculture is not nearly so highly developed on the sandy soils bordering the Bay of Biscay as it is in the western and northern parts of France. The "black earth" region of European Russia is highly fertile and supports a large population. Illustrations might be multiplied.

There is a close relationship between the character of the soil and the crops which will do best in it. Our government is making a soil survey, the results of which show the depth of the soil, its relation to water and temperature, and its composition. Farmers may therefore plant the crops best suited to the given areas. This is one of the many evidences that agriculture is a science, and that man is recognizing his relationship to his environment.

Man and Rivers.—Before the days of railroads, rivers played an important part in the development of the lands because many of the streams afforded an easy and a cheap means of transporting people and products. The St. Lawrence, Hudson, Mississippi, Amazon, Parana, Seine, Rhine and Danube are illustrations.

Although the railroads have taken from the rivers much of their former importance as trade routes, the amount of freight yet shipped on streams is, in the aggregate, very large. The commodities handled are chiefly the bulky and non-perishable ones. All of the rivers mentioned above, as well as many others, bear a considerable commerce even today.

The diversion of stream water has converted desert areas into regions of great productiveness where prosperous communities live happy lives. Egypt has for many centuries been called the "gift of the Nile," because without the life-giving waters of this stream Egypt would be what the land but a few miles on each side of the river is—a desert. In northwestern India irrigation has reclaimed large areas. Although millions have been spent upon irrigation projects in the United States, the work is yet in its infancy. In the arid portions of our western states there is much land which in its natural condition was unproductive, but which because of irrigation now yields large crops.

Little by little for thousands of years man has been learning to utilize the forces of nature, thus lightening his physical burdens, and adding to his comfort, pleasure, wealth and usefulness. For untold centuries the force of falling water was expended solely upon the soil and the rocks with which it came in contact. Thus were fashioned many of our beautiful waterfalls, gorges and canyons. Man has now harnessed this power, and at his bidding it grinds his grain, saws his lumber, operates the machinery in his factories, propels his cars and illuminates his cities.

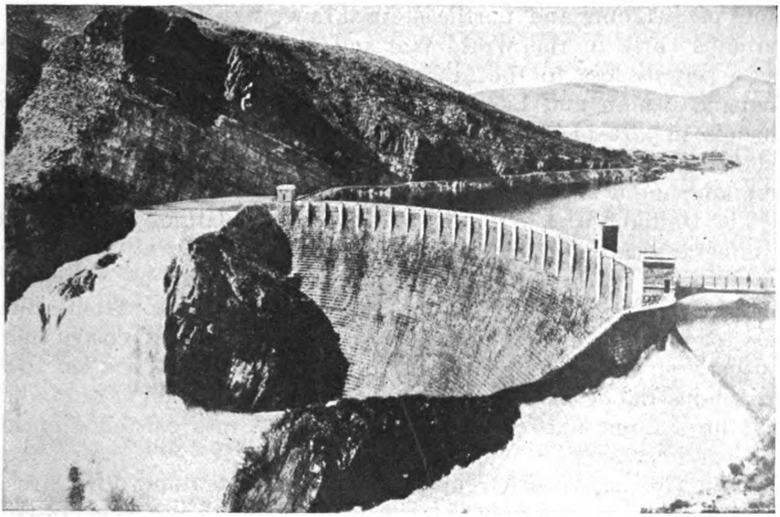


FIG. 5.—Roosevelt Dam, Salt River, Arizona. (U. S. Reclamation Service.)

Man and Minerals.—Long before the beginning of the Christian Era the Phœnicians braved the perils of the sea in order to secure tin from the mines in the Cornish Peninsula. The mineral wealth of Peru and Mexico led the Spanish to make extensive sea voyages, and in more recent years the discovery of mineral wealth has led to large movements of population.

The rank of Great Britain as an industrial and commercial nation, as a naval and as a great world-power, is due in large measure to her vast stores of coal and iron. Not only are these deposits close together, but they are close to the sea-coast. It is the coal of England which indirectly is exchanged for raw cotton, wool, wheat, meats, lumber, fruits and other commodities. Owing to the proximity of coal and iron the "Black Country" is a beehive of industry, where cotton and woolen goods, boots and shoes, cutlery, machinery and a host of other things are manufactured.

Italy, on the other hand, owing to her geology, is very deficient in minerals. She has, however, a very large supply of one mineral—sulphur. Sicily is the chief source of supply, producing about 500,000 tons annually. While lack of mineral wealth hinders the industrial development of Italy, it must not be supposed that this is the only cause.

Belgium and France have large deposits of coal and iron. The mines of Belgium and northeastern France were captured by the Germans early in the World War and held until its close. This was a serious loss to the Allies. Lyons, St. Étienne, Paris, Lille, Roubaix, Namur and Liège are cities the industrial importance of which is in part due to the proximity of coal and iron. The Rhine Valley is one of the great coal and iron producing sections of Germany, and it also is a great industrial district.

The United States is the most favored of all nations with respect to mineral wealth. The value of our mineral products is approximately equal to the mineral wealth of all other nations combined. This is the more important as our coal and iron deposits often occur close together, thus making manufacturing much less expensive than it otherwise would be. Our enormous mineral wealth has led to a great industrial development, promoted the construction of railroads, built up a large lake commerce and brought into existence many towns and cities.

Pennsylvania, West Virginia, northern Alabama and other areas in our country are rich in coal and iron deposits. The "New South" owes its progress in no small degree to the existence of its coal and iron now extensively used in manufacturing.

The discovery of gold in California was the cause of a most remarkable influx of population and the rapid development of the state in pre-agricultural days. Because of her rapid growth in population, California was admitted to the Union as a state rather than as a territory. The gold of California played a part also in leading to the early construction of the first trans-continental railroad.

The presence of large quantities of building stone, if situated near great centers of population, furnishes employment to thousands of men, and investment for large sums of money. The marble quarries of Vermont and the granite quarries of Maine and Massachusetts are illustrations. The Silurian limestone which underlies much of the central part of the Mississippi basin has led to the development of extensive quarries at Joliet and Lemont, Illinois, and has given the nickname of "Stone City" to the former.

The great deposits of clay in the vicinity of Chicago and Milwaukee are of much importance to those cities. Milwaukee pressed bricks are shipped to many points. Good pottery-clays have led to the manufacture of world famous pottery and porcelain at East Liverpool, Ohio, Trenton, New Jersey, Sèvres and Limoges, France, and other places.

One of the very remarkable results of mineral deposits upon human life is seen in Australia. More than 300 miles from the western coast of this continent, in the midst of a forbidding desert, thriving cities have been built. In order to make this possible a pipe line nearly 300 miles long and about three feet in diameter was laid. This conveys water to some fifty towns, most of the inhabitants of which are directly or indirectly interested in gold mining.

Rich deposits of iron in the Lake Superior region, transportation by the lakes, extensive beds of coal and limestone in the vicinity of the head of Lake Michigan, and a great demand for the articles into the construction of which iron and steel enter, led to the creation of a town upon the sand dunes of northern Indiana. Here on the shore of Lake Michigan the raw products can be cheaply assembled, and from here this manufactured iron and steel can be cheaply distributed. The busy city of Gary, with its man-made harbor, came into existence because of the iron and steel industry, and is a wonderful human response to a combination of geographic conditions.

Man and the Coast.—Owing to the configuration of the British Isles no part of them is far removed from the ocean. Arms of the sea penetrate the land from all sides. This has placed a large part of the population in close proximity to the water. Fishing, commerce and numerous seaports are the natural results. The longest land haul, whether for exports or imports, is less than 100 miles.

Because of the ruggedness of the topography of Norway, the support of the people comes in large measure from the ocean. Most of the population is situated close to the sea. The towns and villages are located at the heads of the fiords, and the best means of communication between them is by water. As one result of these conditions, Norway furnishes many seamen who help to operate the merchant marine of other nations.

Irregular coast lines, when well populated or when supporting considerable commerce, must be protected. The protection is expensive. Along all such coasts lighthouses, buoys, bells and life-saving stations are maintained. Harbors are carefully charted and exact depths are recorded. Tide tables are published and storm warnings issued for the benefit of mariners. Our Atlantic coast and the coast of western Europe are excellent illustrations.

A very regular coast line, such as that of Africa, retards the development of commerce. The coast of Peru and the northern coast of Chile are very deficient in harbors and ocean commerce is therefore carried on at a great disadvantage.

Where harbors are not sufficiently protected naturally, break-

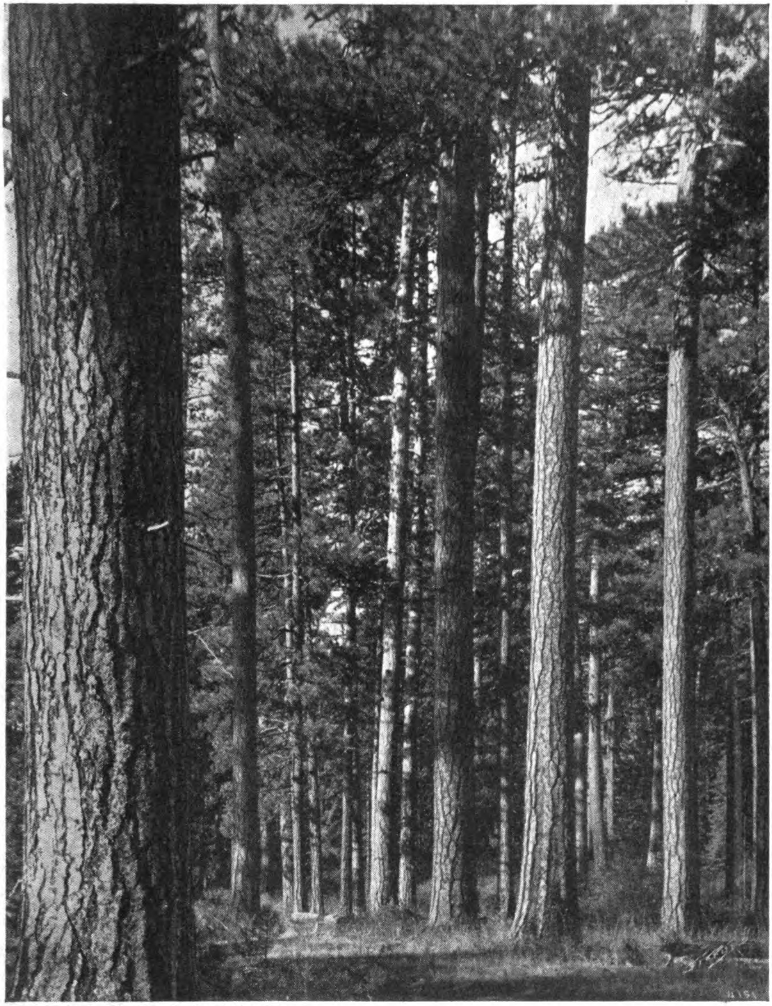
Photo by Chamberlain.

FIG. 6.—An irregular coast.

waters are often constructed at great cost. Lack of area and depth are remedied by dredging.

Man and Forests.—There are large areas in the tropical parts of Africa and South America where, owing to abundant precipitation and high temperature, there is a dense forest growth. The trees grow so close together that there is a perpetual twilight in the forests. A jungle of smaller forms of tropical vegetation occupies the space between the trees, and creepers add to the difficulty in traveling. These forests are inhabited but the population is not dense. To clear the land is an undertaking of great magnitude, and it is very difficult to keep it cleared because of the rapid growth of vegetation.

The people in these forests have not developed agriculture exten-



Courtesy Gifford Studio, Portland, Oregon.

FIG. 7.—A forest.

sively. Manufacturing and commerce are relatively unimportant. As a rule the inhabitants have only temporary dwellings and are quite nomadic in their habits. The natives in the tropical forests of South America, Africa and New Guinea are illustrations.

Temperate latitude forests, although not so dense as those in tropical areas, discourage settlement. There are great forest belts in Siberia and Canada, and partly because of this, the population in these areas is sparse. The northern sections of Maine, Minnesota, Wisconsin and Michigan illustrate the same point. The dense forests in the northwestern part of California and in parts of western Washington and Oregon are in a measure responsible for sparse population. In these, and in many other temperate latitude forests, the main industry is lumbering and other occupations growing out of the products of the forests.

MAN'S DEPENDENCE

The works of man are marvelous. No one can measure his power or his possibilities, yet he is by no means independent of nature. His progress is more or less definitely shaped and guided by the physical conditions by which he is surrounded. In the childhood of the race man accepted the conditions which Nature imposed upon him, though in some cases he offered sacrifices hoping to appease her anger, or to secure larger benefits from her. Today, as has been indicated, man modifies his physical environment, and often overcomes unfavorable conditions. He can utilize and distribute, but he cannot create the forces and the riches of nature.

In a direct sense human beings are not so dependent upon nature now as they were formerly, but indirectly they are more dependent. When the writer's parents were children, people living in the country produced practically everything required for their own use. Grains, vegetables, fruits, meats and fibers were produced upon the farms. The making of butter, cheese, clothing, shoes, soap and many other things were household industries. The ordinary farmer in many cases built his own house.

Today, owing to specialization of labor, household industries have practically vanished from our country. Many farmers buy much of their own food, and clothing is seldom made in the home. In the mills and factories each person performs some limited line of work.

Before the days of extensive commerce people depended very largely upon the resources of their own localities. Today the ordinary family in any highly civilized country depends upon many parts of the world for the articles which are served at an average meal. There is the same dependence upon the outside world for all of the necessities and luxuries of life.

This makes it evident that the indirect dependence of man upon nature is very great. A partial failure of the cotton crop in the United States is seriously felt in many distant countries. A drought which greatly reduces the exportation of wheat by any one of the great wheat exporting countries, increases the cost of bread in the British Isles. If an early frost largely lessens the yield of corn in the United States, the price of pork advances at home and abroad, for our "corn belt" is the greatest hog raising region in the world. When hurricanes devastate the sugar plantations in Cuba, the cost of sugar to American housewives is increased, because we import Cuban sugar extensively. Many illustrations of this kind might be given.

Climatic conditions, topography, soil, streams, forests, mineral wealth, shore lines—these constitute the physical environment of man. The science of geography deals with the origin and the evolution of this environment and with the relations between it and human life. It is therefore a subject of the deepest interest and the greatest importance. Its pursuit leads the student into every part of the world, and into countless activities of human life. Without a knowledge of geography neither history nor the events of the day can be correctly interpreted. It makes possible a much greater enjoyment of the forms and forces of nature than could be had otherwise. In a word, the purpose of geography is to give its students a better understanding of "the earth as the home of man."

STUDIES.

Make a careful study of the influences of geographic environment in your own state or locality. What factors are the most important?

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CHAPTER II

The Earth and Its Neighbors

THE EARTH

Form of the Earth.—The discovery of America by Columbus was nearly prevented by the fact that his sailors believed the earth to be flat, and that if they persisted in their westward journey, their ships would in time plunge over the supposed edge of the earth. So fearful were the sailors that this would happen, that they implored their commander to turn back toward Europe, and they finally threatened to put him in chains unless he would do so. But the faith and determination of the leader triumphed.

This voyage did not prove the earth to be a sphere, but it helped to free men's minds from some of the superstitions of the time, and it gave them more confidence in sailing the seas. People have since traveled around the world along many different lines, and everywhere its surface has been found to be curved. Long before the days of Columbus there were those who believed the earth to be spherical. Indeed, this theory was advanced by Pythagoras (582-507 B. C.), but it was not generally accepted for 2000 years. If this seems to you a remarkable circumstance, consider what you have actually observed which would lead you to conclude that the form of the earth is that of a sphere.

Scientists have actually measured the diameters of the earth, and the measurements show the equatorial diameter to be 7926.6 miles and the polar diameter 7899.6 miles. We see from this that the earth is practically a sphere. The variation from this form is so slight that in the case of a two-foot globe it could not be detected by the unaided eye.

When the shadow of the earth is thrown upon the moon an eclipse of the latter occurs. Eclipses of the moon have taken place with the earth in many different positions but the shadow cast by the earth has in all cases been a circle. This may be taken as strong evidence that the earth is substantially spherical.

If a person makes a long journey in a north or south direction, stars with which he is not familiar appear and rise higher and higher as he continues his journey, while the ones with which he is familiar in his home locality are correspondingly depressed. With a very slight variation due to the flattening of the earth in polar regions, stars appear to rise or fall 1° to each 69.17 miles traveled. This shows that the earth is practically a sphere, and at the same time it furnishes a means of measuring the polar circumference of the earth.

The weight of a body is the measure of the attraction between the earth and that body. The nearer a body upon the surface of the earth is to the center the greater the attraction, hence the greater the weight. The weight of a body is conditioned by another fact. Centrifugal force, which varies from zero at the poles to a maximum at the equator, reduces the force of gravity, hence it reduces the weight.

The weight of a body at the equator, as compared with its weight at either pole, is reduced $\frac{1}{590}$ because of increased distance from the center of the earth, and $\frac{1}{289}$ because of centrifugal force. The total reduction amounts to $\frac{1}{195}$ of the whole. A quantity of flour which would weigh one ton at the north pole would weigh only about ten pounds less at the equator.

We find in this a proof that the form of the earth varies but slightly from that of a sphere, and also an exceedingly inportant result of the form of the earth.

Latitude and Longitude.—Latitude is distance north or south of the equator and is therefore measured along north to south lines. The word latitude is from *latus*, meaning wide. Longitude is distance east or west of some specified meridian; unless otherwise stated, the meridian which passes through Greenwich, England. Longitude is measured along east to west lines. The word longitude is derived from *longus*, meaning long. The people who first applied the terms latitude and longitude believed the greatest extent of the earth to be from east to west. Degrees of latitude are practically the same in length, but degrees of longitude are not.

Rotation.—The earth rotates from west to east, which causes the sun and the stars to appear to revolve in the opposite direction. The period of the earth's rotation as measured by the transit of a star, which is the interval between two successive movements of a particular star across a given meridian, is 23 hours, 56 minutes, 4 seconds.

All points upon the earth's surface complete a rotation in this period of time, but they rotate at very different rates. The top of Eiffel Tower rotates more rapidly than does the base, hence a ball dropped from the top of the tower, and on the east side of it, should strike the ground to the east of the base of the tower. It is very difficult to verify this by experiment, however.

Rotation gives a right-hand deflection to bodies moving over the earth's surface in the northern hemisphere, and a left-hand deflection in the southern hemisphere. Thus the direction in which winds and ocean currents move is influenced by the rotation of the earth. North or south flowing rivers wear their right hand banks more if in the northern hemisphere, and their left hand banks more if in the southern hemisphere. The law relating to this deflection is known as Ferrel's Law.

As a result of rotation, the earth turns now one face and now another toward the sun, giving us our succession of day and night. Were the earth stationary, one-half of its surface would never receive sunshine, and would therefore be incapable of sustaining life. Were the period of rotation increased or diminished, the length of our day and night would be changed accordingly.

Sun time, or solar time, is the same at all points on a given meridian at any particular instant, but at no two points on a given parallel is sun time the same at a specified instant. This is a very important result of rotation. Since the earth rotates eastward (anti-clockwise), time travels westward, or clockwise.

Because a point on the earth's surface rotates through 360° in twenty-four hours, it rotates through 15° in one hour. When it is noon at New York it is midnight on the meridian exactly opposite New York. It is evident when we consider the whole suface of the earth that there are two days in operation at the same time.

Let us start from New York at six o'clock in the morning on a trip around the world following a parallel and carrying correct time according to the sun at New York. When we have traveled 15° west we find that our time is one hour *fast* according to the sun, for we are carrying New York time. We therefore set our time back one hour, which is an apparent loss of this length of time. For each 15° of longitude traveled, this process must be repeated. In traveling the 360° in the circumference of the earth there would be an apparent loss of twenty-four hours, or one day. If these changes were not made, we should find upon reaching home that our day and date were one behind those in force there. If we were to travel eastward around the world we would apparently gain a day. Travelers used to have this very experience.

International Date Line.—To avoid such confusion of days and dates, what is known as the International Date Line has been agreed upon. Figure 8 shows that this is practically the 180th meridian. All days and dates are thought of as beginning at this line at midnight and traveling *west*. A given day encircles the earth in twenty-four hours and comes to a close at midnight at the Date Line.

Almost exactly twenty-four hours after the day begins *at the Date Line*, it begins at the meridian 1° *east* of that line. Here, as elsewhere, the day will last for twenty-four hours. Hence a given day is in operation forty-eight hours. Upon crossing the Date Line sailing west, the day of the week and the date of the month are each advanced one but the *time of the day is unchanged.* The opposite change is made upon crossing the line sailing east. Thus the whole apparent gain or loss resulting from a trip around the world is corrected at once.

It is obvious that this change of day and date should be made as far from land as possible. On this account the 180th meridian is a very advantageous one. In order that all of Russia may have the same date, the Date Line swings about eleven degrees east of the 180th meridian so as to clear Cape Deshnef. In the neighborhood of the Aleutian Islands the line swings west of the 180th meridian to give to the Aleutian Islands the same date as is in force in the United States. The departure of the Date Line from its theoretical position east of Australia gives to the Fiji Islands, New Zealand and Chatham Island the same date. If the International Date Line and the 180th meridian absolutely coincided, a given day could be in operation but forty-eight hours. Fig. 8 shows that Cape Deshnef, latitude 169° west, and Attu Island, latitude 173° east, are points in the Date Line. When January 1st of any given year was just beginning at Attu Island, it was one hour and twelve minutes old at Cape Deshnef. When the day came to a close at Attu Island, it was twenty-five hours and twelve minutes after it began *at Cape Deshnef.* When the day was just closing at Attu Island, it was just beginning at a point immediately east of it. The day of course lasted twenty-four hours at this point. There is therefore a period of forty-nine hours and twelve minutes during which the same day is in force upon some part of the surface of the earth.

Standard Time.—We have seen that solar time differs at all points on a parallel circle. It is evident that it would be exceedingly confusing to operate trains or to keep appointments if each town in the United States did business according to local solar time. And even this arrangement would not take into account the vast rural areas. It was not until 1883, however, that a standard system of time was adopted in the United States. The establishing of the system was the work of the railroads, but the credit for suggesting the matter seems to belong to Professor Cleveland Abbe, who, as Chief of the Weather Bureau, had found great difficulty in securing simultaneous observations of weather conditions in different parts of the country.

The surface of the United States has been divided into four north to south belts, each theoretically 15° in width. At any instant *all* points within a given Standard Time Belt have the same standard time. Time within the belt is fixed by the time of a meridian passing approximately through the center of the belt. When it is noon by the

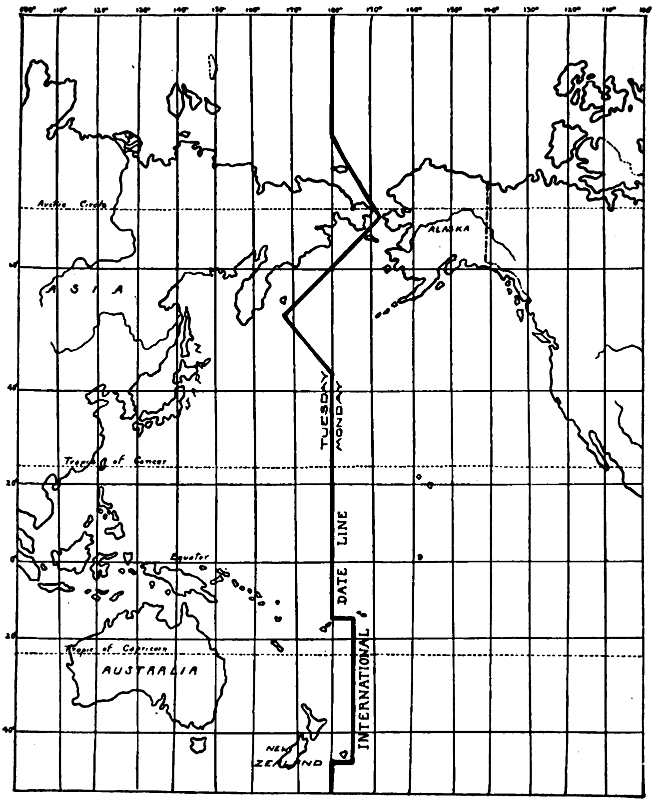

FIG. 8.—International date line.

sun on the 75th meridian, it is noon by standard time at all points in the Eastern Time Belt. Central Time is governed by the 90th meridian, Rocky Mountain Time by the 105th meridian, and Pacific Time by the 120th meridian. Thus when it is noon in New York, it is nine o'clock in the morning in San Francisco.

The boundary lines of the belts are irregular and are drawn to suit

FIG. 9.—Standard time belts.

the convenience of the railroads. The lines usually pass through towns which are the ends of divisions where train crews are changed. Upon crossing a boundary line, time is put back one hour if traveling westward, ahead one hour if traveling eastward. No change is made in day or date except at or near midnight.

On May 1, 1914, Cleveland, which had previously been in the Central Time Belt, adopted Eastern Time as its standard. Standard time is in vogue in Europe, that continent having three time belts. It was adopted by Brazil on January 1, 1914, the republic being divided into four time belts.

The invention of the telegraph made it possible to compare and correct time in areas widely separated. For about fifty years time has daily at noon been telegraphed from Washington, D. C., to points east of the Rocky Mountains and from San Francisco to points in the western part of our country.

Revolution.—We speak of certain persons as being travelers, but as you have seen, all of the inhabitants of the earth are daily carried thousands of miles as a result of about 25,000 miles rotation of the earth. While we are making this daily journey, we are performing a part of a marvelous annual trip around the sun. The distance covered by this yearly journey is 584,000,000 miles, the time is three hundred and sixty-five days, five hours, forty-eight minutes, forty-five seconds, and the average rate is a little more than 1000 miles per minute.

This movement of the earth is known as revolution. All of the planets revolve about the sun, but their periods of revolution vary greatly. The elliptical path which the earth follows in making its annual journey is known as the *earth's orbit*. The mean distance of the earth from the sun is approximately 93,000,000 miles, and the difference between the maximum and the minimum distance is only about 3,000,000 miles. This difference is so slight *relatively*, only about one-thirtieth of the mean distance, that in diagrammatic representations of the orbit a circle is usually employed.

Change of Seasons.—One of the most wonderful of our experiences is the change of seasons, due to revolution, rotation, and the inclination of the earth's axis. About the first of January the maximum distance of the earth from the sun, approximately 94,500,000 miles, is reached. This position is called *aphelion*, from *a*, meaning away from, and *helios*, the sun. About July first the minimum distance, practically 91,500,000 miles, is recorded. This position is called *perihelion*, from *peri*, meaning around or near, and *helios*, the sun.

Fig. 10 shows the earth revolving about the sun in a plane which passes through the center of the bodies. Position "A" represents the relation between the earth and the sun on September 22d. As neither the northern nor the southern hemisphere is turned toward or away from the sun, the vertical ray of the latter falls upon the equator. The boundary between the illuminated and the dark parts of the earth (the circle of illumination) passes through the poles, and bisects all parallel circles. Since one-half of each parallel circle is in the light and one-half in the shadow, the periods of darkness and light (day and night) are everywhere equal and twelve hours long. Because of this fact this date is called *equinox*, from *æquus*, meaning equal, and *nox*, meaning night.

At all times the earth's axis is maintained parallel to its position at "A." As the earth journeys toward "B," the northern hemisphere turns from the sun and the opposite hemisphere toward it. On December 22d the north pole is turned 23° 30′ from the sun. The vertical ray now falls an equal distance south of the equator, and the circle of illumination lacks 23° 30′ of reaching the north pole and reaches 23° 30′ beyond the south pole. At this time all parallel circles but the equator are divided unequally by the circle of illumination, and therefore day and night are of equal duration at the equator only.

In the northern hemisphere, less than one-half, and in the southern hemisphere more than one-half, of each parallel circle is in the sunlight. Therefore in the northern hemisphere days are less and in the southern hemisphere more than twelve hours long.

As the amount of solar energy received depends upon the angle at which the sun's rays fall upon the earth the northern hemisphere now has winter and the southern hemisphere summer. December 22d is the date of the winter solstice in the northern hemisphere. At this time the apparent southward journey of the sun gives place to its apparent movement toward the equator.

As has already been stated the earth is nearest to the sun during the period of summer in the southern hemisphere. Because of this, a little more solar energy is received in this hemisphere during its summer than is received in the northern hemisphere during the northern summer. But owing to the fact that the earth is a little nearer to the sun during the southern summer, the rate of the earth's revolution is increased. The result of this is that the southern summer is seven days shorter than is summer in the northern hemisphere.

On March 21st the earth has reached position "C." Observe that neither hemisphere is turned toward the sun, that the vertical ray falls upon the equator and that the circle of illumination passes through the poles and bisects all parallel circles. Again day and night are equal (twelve hours each) on all parts of the earth's surface. This is the date of the spring equinox.

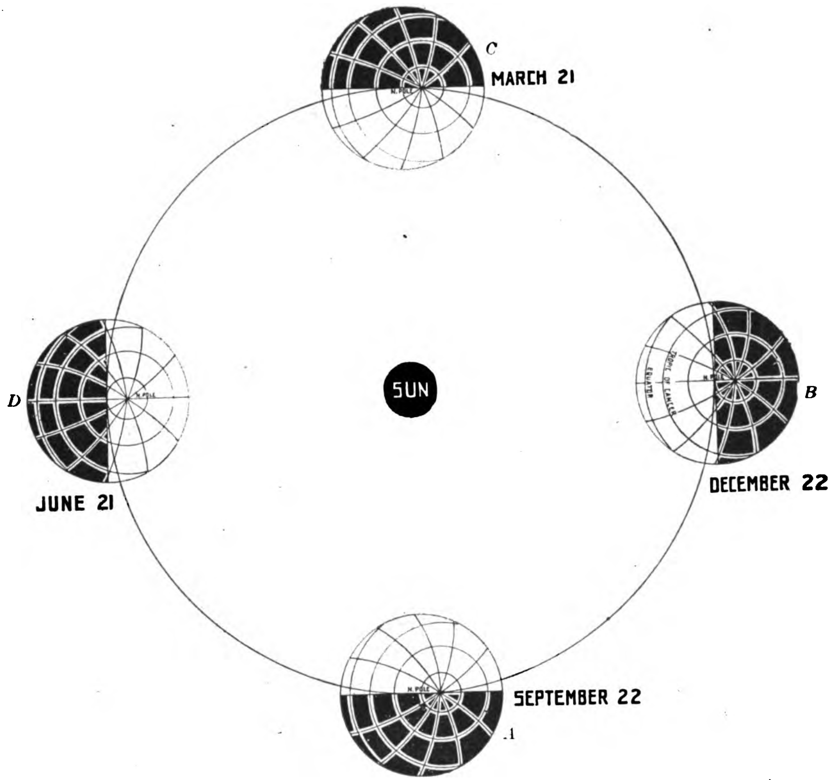

FIG. 10.—Change of seasons.

The earth reaches position "D" on June 21st. The north pole is now turned toward the sun, and the vertical ray falls 23° 30′ north of the equator. The circle of illumination extends the same distance beyond the north pole, fails to reach the south pole by the same number of degrees, and divides all parallel circles but the equator unequally.

At this season more than one-half of each parallel circle in the northern hemisphere, and less than one-half of each parallel circle in the southern hemisphere, is in the sunlight. Days are therefore longer than nights north of the equator, and shorter than nights south of the equator. The most direct rays fall in the northern hemisphere, which therefore has its summer. June 21st is the date of the spring solstice or time when the apparent northward movement of the sun ceases and the apparent southward movement begins.

Note that on September 22d the circle of illumination passes through the poles. The next day it has passed beyond the north pole and does not quite reach the south pole. There is then a small circle surrounding the north pole within which the sunlight does not fall during a complete period of rotation. There is an equal area surrounding the south pole which is illuminated during the whole of a period of rotation. The next day the diameter of the continuously dark circle has been increased slightly, as has that of the continuously light circle surrounding the south pole. This continues until December 22d, when these circles reach their maximum diameter, 23° 30′.

Between December 22d and March 21st the diameter of the non-illuminated circle steadily shortens, as does that of the illuminated area surrounding the south pole, and on the date first mentioned the circle of illumination once more passes through the poles.

For a period of six months, September 22d to March 21st, the north pole has continuous night and the south pole continuous day. The length of the night diminishes from this maximum at the north pole to a period of twenty-four hours on the circle 23° 30′ from the north pole. Similarly during the same time the length of the period of sunshine diminishes from six months at the south pole to a day of twenty-four hours on the circle 23° 30′ from this pole. Everywhere on the equatorward sides of the Arctic and Antarctic circles a part of every parallel circle is turned toward the sun during every period of rotation. Therefore nowhere within these latitudes can there be a day or a night of twenty-four hours' duration. As the circle of illumination *always* bisects the equator, day and night are always equal and twelve hours long on the equator.

The Zones —It has been noted that during a period of revolution the vertical ray travels over a zone extending 23° 30′ each side of the equator. This is the *tropical zone* and is bounded by the tropic of Cancer on the north and the tropic of Capricorn on the south.

Those parts of the earth's surface within which the minimum period of sunlight or darkness (depending upon the season) is twenty-four hours, are the *frigid zones*. The north frigid zone is bounded by the Arctic circle, and the south frigid zone by the Antarctic circle.

That part of the earth's surface 43° in width, and bounded by the Arctic circle and the tropic of Cancer, is the *north temperate zone*. The corresponding area south of the equator is the *south temperate zone*.

If the earth's axis were inclined 1° from a perpendicular to the plane of its orbit instead of 23° 30′ as at present, the vertical rays would shift over an area extending 1° on each side of the equator, and the tropical zone would have a total width of 2°. If the inclination were 2°, the width of the torrid zone would be 4°, and so on. The width of each zone is therefore directly or indirectly fixed by the inclination of the axis.

THE SUN

To the inhabitants of the islands of the sea, a most wonderful spectacle is daily presented. Each morning, if the sky is clear, the sun, like a great ball of fire, appears to rise from the waters in a general easterly direction. Hour by hour it mounts higher in the sky and then declines, and finally appears to sink beneath the waves in the western horizon.

Those who dwell inland witness the same apparent daily journey of the sun about the earth, although the phenomenon is less impressive. It was quite natural that people should believe that the sun actually performed this journey, and it was not until the time of Copernicus (1473-1543) that they were undeceived. We now know that the earth rotates daily upon its axis, which causes the sun to *appear* to revolve about the earth in the same time.

You are aware that in various ways the sun influences your daily life. Have you ever realized that your life depends absolutely upon the sun? If there were no sun, there would be no streams gurgling over pebbly beds, no winds whispering among the treetops and no waves dashing upon the shores. But for the sun, there would be neither flowers, grass, nor trees to give beauty to the earth, and no crops could grow in the fields. Without sunshine, not even man with all of his power could live upon the earth.

The sun, although a very distant neighbor of the earth, is the chief factor in the physical environment of man. In every phase of the subject of geography you will learn of the direct and indirect effects of the sun upon your life, and that of all other human beings. Because of this, it is important that we know something of the sun itself.

You have learned that the earth is about 93,000,000 miles from the sun. The figures are not of much value to us in this case, for we can form no conception of the distance which they represent. If it were possible to travel from the earth to the sun maintaining an average speed of 60 miles per hour, the journey would require about 175 years.

The sun is a gaseous body, at least in its outer portion, and is in a state of combustion. It is the heat and light resulting from combustion and contraction of the sun which warm and illuminate the earth. Do not think that we receive all of the solar energy. It is estimated that only about $\frac{1}{2,000,000,000}$ part is received by our earth.

The diameter of the sun is more than one hundred times that of the earth, and its mass is about 332,000 times the mass of our planet. The spectroscope shows that the same elements which exist in the earth's crust exist also in the sun. If these elements are in a gaseous or a liquid form, the temperature must be very high. It is believed that at the surface of the sun the temperature is 6000° F. or higher.

The Solar System.—The sun is the controlling power in the group of bodies known as the solar system. The members of this system, named in the order of increasing distance from the sun, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. These bodies are called *planets*. Most of them are attended by one or more moons, or *satellites*.

Among astronomers it is not generally believed that planets other than the earth are inhabited, as the conditions appear to be unfavorable to the existence of such life forms as those with which we are acquainted. There has been some discussion regarding the probability of human life upon Mars. The mean distance of this planet from the sun is about one and one-half times as great as ours. Unlike the earth, however, the difference between the maximum and the minimum distance is very marked. The mean length of its day is twenty-four hours, thirty-seven minutes, and the inclination of its axis is 24° 50′. The telescope shows a system of lines upon this planet which a few astronomers believe are great irrigation canals. What are believed to be polar ice caps have also been discovered. The lines are most noticeable at the time of the year when the polar snows would be melting. The theory is that owing to the melting snow, vegetation springs up along the canals, and it is this and not the water which is seen.

THE MOON

For ages people have regarded the moon with great interest. It has been believed that she exercised a great influence upon the lives of men, as well as upon weather and crops. Superstition, song and story have been woven about the "goddess of the night," and she has been worshipped by the peoples of many nations.

Because of the relatively short distance between the earth and the moon, about 240,000 miles, the latter is a beautiful and a conspicuous object. Although the moon is very brilliant, it shines by reflected sunlight. When the part of the earth upon which we live is turned away from the sun, the moon furnishes us with reflected sunlight. When a portion of this light falls upon a house and is reflected to our eyes, we see the building. The house is therefore visible by means of sunlight which has been twice reflected.

Everyone has observed the spots upon the surface of the moon, but it was not until Galileo in 1610 trained his telescope upon her that it became known that these spots are hills and mountains. Many of the mountains are extinct volcanoes.

Although the telescope shows that the moon has a land surface, it reveals no water. Neither water nor atmosphere are believed to exist upon the moon. Hence it is thought that it can have no life such as that with which we are familiar.

As the earth revolves about the sun, so the moon revolves about the earth. And as, according to the Nebular Hypothesis, the earth is believed to be the child of the sun, so the moon is regarded as the offspring of the earth.

The moon revolves in about twenty-nine and one-half days, and as the periods of rotation and revolution are identical, the same face of the moon is always turned toward us. As it takes three hundred and sixty-five days for the earth to perform a complete revolution about the sun, it is clear that the period of the moon's revolution is not the equivalent of one of our months.

One half of the moon is constantly illuminated by the sun. But since the moon keeps the same face toward the earth, we see all or none of the illuminated area, according to the relative positions of the sun, earth and moon. When we see all of the illuminated part we say that the moon is full. When only about one-half is visible we speak of the phase as the first or the third quarter. New moon occurs when that part of the moon which is turned toward us is just beginning to receive sunlight.

At times the moon passes between the sun and the earth in such position as to partially or completely obscure the light of the sun. Because of this we have a partial or a complete eclipse of the sun. Occasionally the earth occupies such a position between the sun and the moon that the latter is entirely within the shadow of the earth.

At such times the moon is said to be eclipsed. Primitive peoples were greatly alarmed when eclipses occurred.

Although it is no longer generally believed that the moon influences the weather, crops, health and mental growth, it is related to human life in a very important way. The moon is the chief factor in the production of the tides which have so much to do with the commerce of many seaports.

Gravity and Gravitation.—The force of the explosion of a charge of gunpowder in a cannon may be sufficient to project a cannon ball many miles. Imagine a cannon pointed directly away from the surface of the earth and fired. Why does not the ball continue indefinitely in the direction in which it started? Why does it invariably return to the earth?

It requires a force outside of the cannon ball to set it in motion, and unless that force be overcome the ball will continue in motion. Sir Isaac Newton (1642–1727) stated this in the form of a general law called the *law of inertia*. The law may be stated as follows: Every body continues in a state of rest or of uniform motion in a straight line, unless some force outside itself compels it to change that state.

The force which sets the cannon ball in motion is the explosion; the force which changes its direction of motion and finally brings it again to a state of rest is called *gravity*. This is a force which every particle of matter in the universe exerts upon every other particle. As applied to the earth, this force is called gravity, but as applied to the universe, it is called *gravitation*. It is then gravity which arrests the cannon ball in its flight and brings it to rest upon the surface of the earth. A bird must use muscular energy in order to fly; that is, to temporarily overcome the force of gravity. This use of energy in time exhausts the bird, and as gravity continues to act, the bird must alight or fall to the earth. Gravity causes the raindrops to fall and streams to flow invariably toward sea level. It is gravity which holds human beings to the earth and makes escape from it impossible. Attention must be paid to gravity in erecting buildings. Gravitation is the cause of the tides, as explained in Chapter XV.

Bodies having the greatest *mass*, that is the greatest amount of material in them, have the greatest attraction for each other. The first law of gravitation is: Attraction is directly proportional to the mass of the bodies. For example, let the mass of a given body "A" be represented by 3 and the mass of a given body "B" by 6. Since the mass of B is twice the mass of A, the latter will attract the former with twice the force which A will exert upon B.

The second law is: Gravitation varies inversely as the square of the distance. Let the distance between A and B be represented by 2, and that between A and C by 4. The square of 2 is 4, and the square of 4 is 16. Applying the law, we see that the attraction between A and B is four times as great as that between A and C.

It is because the mass of the sun is so much greater than that of any of the planets that it is the controlling force. And it is because each heavenly body attracts all others that the individual members are kept in their orbits.

The Nebular Hypothesis.—How the solar system originated is not known. Near the end of the eighteenth century, Laplace, a French mathematician, advanced the theory to which the name nebular hypothesis was given. According to the theory it was conceived that all of the material now found in the solar system was once in the form of an immense nebulous mass, similar to nebulæ now seen in the heavens. As a result of contraction this incandescent mass began to rotate. Cooling led to shrinkage, and shrinkage to an increase in the rate of rotation.

In time gravity and centrifugal force became equal on the equatorial portion of the surface. When this condition was reached the outer portion was no longer drawn toward the center of the mass, which continued shrinking. Thus an equatorial ring-like body was left encircling the central mass and rotating about it. Later this equatorial ring was converted into a spherical body and is now known as the planet Neptune. In the same way other rings and other planets were formed. The sun is that part of the original mass not fashioned into planets.

According to the nebular hypothesis the earth was once a vaporous globe highly heated. As a result of cooling it liquefied, and continued cooling resulted in the formation of a solid crust over a molten interior. When the crust had cooled sufficiently, rain water remained upon the surface, and gradually the oceans were formed. In time the atmosphere became sufficiently purified, and its temperature sufficiently reduced, to permit of the existence of low forms of plant life.

The Planetesimal Hypothesis.—In recent years it has been found that the nebular hypothesis does not adequately explain the origin of the solar system. Professors Thomas C. Chamberlin and Forest Ray Moulton, both of the University of Chicago, have worked out what is known as the planetesimal theory.

The telescope reveals many spiral, nebulous masses having luminous centers, and streamers issuing from opposite sides. Along these streamers there are knot-like points where the density appears to be greater than in other parts.

All the particles and the knots of such a spiral nebula are believed to revolve, each in an independent orbit, about the central mass. These bodies are called planetesimals (little planets) because they act as do the planets. It is believed that the knot-like masses may have gradually gathered the planetesimals about them as our earth gathers meteorites. Thus the planets may have come into existence.

If this theory be correct, our earth is the result of the very slow accumulation of particles about a center. When the mass of the earth was relatively slight, gravitation may not have been strong enough to enable it to hold an atmosphere. In time an atmosphere was acquired and later the oceans developed. With the growth of the earth, heat increased, because of the increase in the force of gravity, the center having the highest temperature.

Some of the gases which formed the atmosphere may have been derived from the interior of the earth. Water vapor, nitrogen and carbon dioxide, because they are relatively heavy, were among the gases early acquired. In time the water vapor condensed and rains fell. With water on the surface of the earth, various geological processes were set in motion, oceans were formed, and finally life began.

According to the older theory the earth is steadily cooling, hence its atmosphere is cooling and life will in time become extinct. According to the newer theory, the slow accumulation of particles by which the earth was formed will continue. The atmosphere will slowly increase, and life will continue to evolve.

THE STARS

Centuries ago the stars entered much more largely into the thoughts of men than they do today. The mild climate of the Mediterranean countries favored life out of doors, and this naturally stimulated observation of the heavens. To the people of ancient times the stars were mysterious as well as beautiful, and they played an important part in mythology, literature and daily life. On the occasion of important events, the positions of certain stars were carefully observed. One's life was believed to be in part governed by the star under whose influence he was born. Shakespeare shows us that even in his day this superstition had not disappeared, for he makes Cassius say to Brutus: "The fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings." [1]

[1] "Julius Cæsar," Act 1, Scene II.

Many stars were known and named before the beginning of the Christian Era, but the telescope, invented by Galileo, has revealed a vast number not visible to the unaided eye. The light from some stars, so distant that they are beyond the range of the telescope, affects the sensitive plate of the camera.

Nearly a million stars have been classified, and astronomers believe that there are many millions. Light travels at the velocity of 186,000 miles per second, yet so distant is the nearest star that more than four years are required for its light to reach the earth. Such vast distances, when stated in miles, are meaningless, hence the expression "light-years" is employed. The distance of the star just referred to is four light-years, because four years are required for its light to reach the earth.

Many of the apparently tiny stars are in reality suns, some of them larger than our world. They are thought to be incandescent bodies of gas, shining by their own light.

When you spend a cloudless night out of doors, far removed from the glare of city streets, you can in a measure appreciate the Bible statement: "The heavens declare the glory of God."

In speaking of the wonders of the heavens Emerson says:

"If the stars should appear one night in a thousand years, how would men believe and adore and preserve for many generations the remembrance of the City of God which has been shown."

STUDIES

Why did the people of long ago believe the earth to be flat? Does the circumnavigation of the earth prove the earth to be a sphere? Ascertain the difference between standard and solar time in your city. Find the length of the longest day in your latitude. Compare the length of winter in the northern and in the southern hemispheres. If a person were on the Arctic circle on December 22nd, where would he see the sun at noon? At what angle does the most direct ray of the sun fall in your latitude?

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CHAPTER III

THE ATMOSPHERE

General Statement.—Imagine yourself held by an invisible, a mysterious, yet an irresistible power, to the bottom of the ocean. You are free to move about, to climb to the tops of submerged mountains, to engage in various occupations, but you cannot escape from the floor of the sea. About and above you glide fishes of varied form and hue, whose movements are supported by the waters. Far above your head is the never ceasing roll of the waves, while a gentle movement of the waters twice each day is the only indication of that wonderful response which the ocean makes to the attractive power of the moon and sun.

This strange, imaginary situation is more than equaled by the sober facts. You *are* chained to the floor of a sea so vast that the great watery expanse sinks into insignificance beside it; so vast that the exact position of its surface is unknown. Miles above your head its great waves roll to and fro. Currents many miles in width flow forever onward, each in a well defined course, while mighty tides sweep round and round the planet. Birds and other creatures with ease and grace dart here and there through this transparent sea, sometimes rising almost beyond the limit of your vision. But you are compelled to spend your life at the bottom of the flood in which you are submerged. Indeed, were it possible for you to escape from it you could live but a very few minutes.

This vast atmospheric sea, on the floor of which every individual lives, surrounds the earth, extending outward from its so-called surface for a great but an unknown distance. It mingles with the less extensive aqueous sea, and it penetrates, to some extent, the crust of the earth.

The movements of this boundless sea are under the control of the sun. While never at rest, it is sometimes quite calm, but at other times great storms sweep through it. Now, in response to a magic touch, seeds germinate, a mantle of green covers the earth, and blossoms beautify the landscape. Again by another magic touch, plant life withers, animals migrate, the streams and lakes are sealed with ice, and even man is compelled to change his habits of life.

The atmosphere is the most vital factor in our environment. Food and drink we must have at intervals, but deprive us of the atmosphere, and we perish at once. While we are, to a certain extent, unconscious of its presence, we are immediately conscious of unusual changes in its condition. Aside from being an absolute necessity, the atmosphere exerts a marked control over our food supply, the nature of our clothing, our homes, our methods of travel, our health, our business, our pleasure, and our mental and moral qualities. Even our great coal deposits are definitely related to atmospheric conditions which existed ages ago. An understanding of atmospheric conditions and controls is invaluable to the mariner, the farmer, the fruit-grower, the cattle raiser; to those who, in great cities, deal in the products of the soil; to the builders of railroads, water-works, and bridges, and to the home and health-seeker.

Atmosphere Diffuses Heat and Light.—The atmosphere, while not retarding the movement of solar energy, or *insolation*, from the sun to the earth, does hinder in a marked degree the escape of heat from the earth's surface. Without the atmosphere the diurnal, or daily, range of temperature would be so great as to make the existence of life, as we know it, impossible. The adjustment between temperature and life is indeed a very delicate one. The sun with its fearful heat of thousands of degrees is constantly facing us. Between our earth and this fiery mass are the depths of space where temperatures hundreds of degrees below freezing point exist. The atmosphere is a mediator, a life preserver. Through its action, temperatures at which it is possible for life to exist are maintained. At a comparatively few miles above sea level, even in the tropical zone, there is a realm of death. This lifeless plane stretches like a curtain over all the earth, being much lower in polar than in equatorial regions. Each night there is stealthy approach of this plane of death toward the sleeping world, but with the return of the sun it again withdraws. Were the whole earth to experience continuous sunshine or darkness for a few weeks human life would in all probability become extinct.

The atmosphere diffuses light as well as heat. In the absence of an atmosphere, places upon which the direct sunlight did not fall would be poorly lighted. The diffusion of sunlight is chiefly due to the dust held in suspension in the air. These dust particles scatter in all directions the light which they receive, thus lighting the air and objects which are in the shade.

Atmosphere Distributes Moisture.—Not only does the atmosphere distribute heat and light, it is the great carrier of moisture as well. Through the process of evaporation, water is taken up from the oceans, lakes and streams, as well as from the lands, and in the form of vapor, borne by the winds to all parts of the world. Under favorable conditions, this moisture is precipitated, thus giving to the regions where it falls in sufficient amount great forests or grassy plains.

Atmosphere Aids in the Distribution of Life.—The winds are important factors in distributing seeds and plants, thus enlarging the range of plant forms. The thistle, tumble weed, dandelion, sticktight, maple and hop are all adapted to wind transportation. Birds are often carried far out of their courses by storms. Human history has been, in some measure, influenced by the movements of the atmosphere. The ships of Columbus and Magellan were drifted before the constant trade winds, and the influence of the monsoons upon the commerce with India was marked in early times. Even today the winds are a factor in ocean commerce. Because of the influence of the trade winds it requires a shorter time to sail from San Francisco to Honolulu than from Honolulu to San Francisco.

Atmosphere Aids in Weathering and Erosion.—To the movements of the atmosphere waves and currents are due. Waves beat against the lands, tearing them down, carrying the waste far and wide, and scattering it over the floor of the ocean, thus filling harbors and building islands, bars, and other shore forms. Ocean currents are great heat carriers, and they are not without influence on ocean navigation at the present day.

The atmosphere is an important geological agent. Increase and decrease in temperature bring about expansion and contraction of the rocks. In this way the outer part is cracked. Fragments of rocks which have been broken off by this process will be found at the base of any cliff. Such an accumulation of material is known as *talus*. On account of its moisture and gases, the atmosphere acts chemically as well as mechanically upon the rocks, thus producing a slow but constant disintegration, the most important result of which is the formation of soil.

The winds erode the rocks by hurling sand grains against them, creating most fantastic forms. Immense quantities of material are carried by the winds for long distances, to be deposited on land or in the sea.

Atmosphere a Part of the Earth.—When we open a window in a rapidly moving express train we feel the apparent rush of the atmosphere as the train cuts its way through it. The earth in the latitude of New York City is rotating eastward at the rate of about 800 miles per hour. Were the earth rotating *through* or *in* the atmosphere, every movable object on its surface would be swept away by the friction. The fact that we are totally unconscious of any such friction may be taken as a proof that the atmosphere rotates *with* the earth—is a part of it.

Extent of the Atmosphere.—How far from the earth the atmosphere extends is not known. It exists on the tops of the most lofty mountains and at the greatest heights reached by sounding balloons,

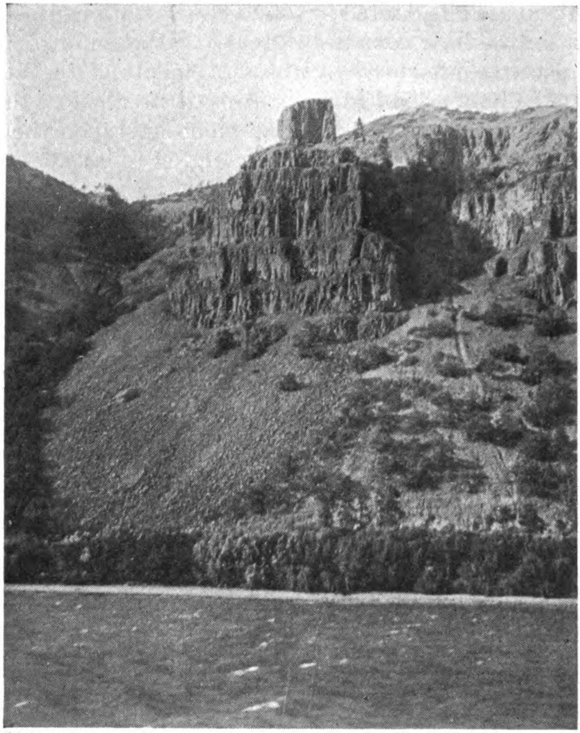

Photo by Chamberlain.

FIG. 11.—A talus slope.

about 22 miles. Astronomical observations show that its outer limit is at least as far as 175 miles from sea level, for meteors have been observed at that altitude. If it were uniform in density, its upper limit would be found at a height of about five miles, for at sea level a column of atmosphere of given cross-section will sustain the weight of a column of mercury of the same cross-section and about thirty inches in height. The density of mercury is 10,784 times that of air at sea level, and 10,784 times thirty inches gives five miles.

As the atmosphere is highly elastic, its density rapidly decreases with increase of altitude. About 900 feet above sea level, and parallel to it, we may picture a surface where the barometer would read twenty-nine inches.

As the volume of gases is inversely proportional to the pressure, a barometric reading of twenty-eight inches would be found at a height of 29/28 of 900 feet above the surface of twenty-nine inches, or at an altitude of 1,832 feet above the sea. According to this, the upper limit of the atmosphere would be found at an infinite distance above sea level.

In passing through the atmosphere meteors generate so much heat as a result of friction that they become luminous. It is believed that they do not become luminous until after they enter the atmosphere. The altitudes at which meteors appear can be at least approximated.

Composition of he Atmosphere.—As is well known, our atmosphere consists of oxygen and nitrogen, mixed, not combined, in the proportion of about 21 per cent. of the former to 78 per cent. of the latter. In addition there is about 1 per cent. of argon, .03 per cent. of carbon dioxide gas, a small amount of vapor of water, dust and various other substances, among them being ammonia, nitric acid, hydrogen, helium and krypton.

By weight the atmosphere contains:—

	Billions of Tons
Oxygen (O)	1,233,010
Nitrogen (N)	3,994,593
Carbon dioxide (CO_2)	5,287
Vapor of water	54,461

Oxygen.—From the standpoint of human life, the most important element in the atmosphere is oxygen. We could not exist for an hour if deprived of it, yet in too large amount it is destructive to life. Oxygen is the most common element in the crust of the earth, constituting 47 per cent. of it, and it forms 86 per cent. of the water of the ocean.

It unites readily with all of the elements but fluorine. In the rusting or oxidation of metals and rocks we have a familiar illustration of the fact that the atmosphere is constantly being deprived of its oxygen. The oxygen is the most important element in keeping down the percentage of carbon dioxide in the blood. The blood, while in the lungs, gains oxygen and loses carbon dioxide.

Few people breathe deeply enough and are therefore deficient in oxygen. The average amount of air taken into the lungs by an adult at each inspiration is about 30 cubic inches. This is only one-tenth of the capacity of the lungs. We inhale about fifteen times per minute and therefore an adult at rest requires about 400 cubic feet of air in twenty-four hours, while a man exercising violently uses from 600 to 1,000 cubic feet in the same time. Although the process of breathing is, for the most part, an unconscious one, it represents a tremendous amount of work. It has been estimated that the energy daily expended in this process by an adult is sufficient to lift twenty-one tons one foot in the same time.

Each living being may be regarded as an engine or a machine. In the case of an engine the fuel, which is largely carbon, unites with oxygen, producing CO_2, heat and light. Similarly oxygen unites with the blood and the food. One of the products of this union is CO_2, which is thrown off by the lungs. The oxygen unites with the food, thus liberating the energy which the latter contains.

Nitrogen.—Unlike oxygen, nitrogen is a very rare element in the crust of the earth, although it is very abundant in the atmosphere. It is spoken of as the inert element of the atmosphere, and does not readily unite with other elements. It increases the density of the atmosphere, thus giving it greater force, making it easier for birds to fly, and enabling it to carry sound farther than it otherwise could. The great value of nitrogen, however, lies in the fact that it supplies food to plants. Farmers have for a long time been in the habit of planting their fields to clover to restore their fertility. It remained for science, however, to discover *why* this result was obtained. Clover and certain other leguminous plants, such as beans and peas, have nodules on their roots. In these are bacteria which abstract nitrogen from the air and supply it to the plants in the form of compounds. This readily suggests wonderful possibilities in agriculture, for science is drawing upon the great atmospheric supply of nitrogen, making it possible to fertilize our fields on a large scale.

Carbon Dioxide.—Carbon dioxide, although small in amount, is one of the most important elements in the atmosphere. All animal organisms inhale oxygen, and exhale CO_2. While directly it is a menace to animal life, since it poisons the atmosphere, indirectly it is the supporter of it, for it is the chief food of plants. The CO_2 is taken up by certain plant cells, and under the action of sunshine, the chlorophyll, a green substance occupying the pores of these cells, decomposes it into oxygen and carbon. The oxygen is liberated, but the carbon is retained to build up the tissues of the plant. This process is known as *photosynthesis*. Thus through the vegetables, grains, fruits and even the meats that we eat, the fibers that enter into the manufacture of our clothing, and the timber of which our homes are constructed, is our own daily life dependent upon carbon dioxide. As plants are constantly taking from the atmosphere the CO_2 given to it by animals, combustion and volcanic action, the air is thus left in better condition for man's use.

It has been noted that the percentage of carbon dioxide gas is somewhat greater by night than by day, and in cloudy than in clear weather. The inactivity of the chlorophyll when the sun is not shining explains this.

Carbon dioxide gas seems to have the property of exerting a great control over the atmospheric temperatures. It is estimated that an increase of 50 per cent. in the amount of this gas would give to the Eskimo a land decked with palm trees, while an equal decrease would result in covering most of the temperate zone with perpetual snow and ice. How largely this figured during the Carboniferous Age and the Glacial Period is not known.

Water carrying CO_2 dissolved in it becomes a very important geologic agent from the standpoint of chemical action, for it dissolves limestone rock quite readily. It was chiefly through such chemical action that our wonderful caverns were formed.

Under the ordinary conditions in the open air the amount of carbon dioxide gas remains practically the same. Exceptions to this are found, however, in the neighborhood of active volcanoes, and certain fissures in the crust of the earth from which the gas escapes. In some of these localities, as in a small valley in Yellowstone Park, the amount is so great as to cause the death of animals. In crowded rooms and cars the percentage is perceptibly increased, and this is usually made apparent by a disagreeable odor. When the air of a room is overloaded with this gas, its very presence tends to check the expulsion of it by the system, and thus a very important and necessary process is retarded.

An adult, when working, gives off about one cubic foot of CO_2 per hour. The burning of a cubic foot of gas poisons the air of a room as much as does a person. With the burning of a single ton of coal there passes into the atmosphere more than 60,000 cubic feet of this gas. This shows the importance of ventilation.

Water Vapor.—The atmosphere in all places and at all times contains some moisture in the form of water vapor. The condition of the atmosphere with respect to water vapor is spoken of as the *humidity* of the atmosphere. Humidity varies greatly according to place and time. On the one hand we have the very dry air of the hot deserts, and on the other, the moisture laden air of the equatorial jungles, with all of the resulting differences in the plant, animal and human life. The atmosphere of a room 40′ x 40′ x 15′ at a temperature of 60° F. can contain 20 pounds of water, or about enough to fill a common water pail.

It is the *relative* not the *absolute* amount of moisture in the atmosphere with which we are chiefly concerned, however. Relative humidity expresses the degree of saturation in relation to the existing temperatures. An increase in temperature expands the air, increases its capacity for moisture, and hence lowers the relative humidity.

Relative humidity is closely related to temperature ranges and to the influence of temperature on life. A low degree of humidity favors rapid radiation and rapid evaporation. Consequently in dry regions it is cool in the shade and at night. But for the water vapor in the atmosphere night temperatures, even in the summer, would be low and the day temperatures would be much higher than they now are. Radiation being much slower in moist regions, a hot day is likely to be followed by a hot night. This results in far more than discomfort. It lowers the vitality, induces disease, and in the case of those seriously ill may retard or prevent recovery.

Through the process of condensation, moisture is being constantly removed from the atmosphere, and through the process of evaporation it is as constantly being restored. The amount of water vapor in the air is measured by an instrument called a hygrometer.

In every cubic foot of water there are believed to be millions of molecules, each vibrating under the influence of the sun. Heat is a form of motion. The more rapid the movement of the molecules the greater the intensity of the heat. In some cases the movement is so rapid that certain molecules leap above the surface of the water, and are carried upward by air currents.

Argon.—Of argon, the most dense of the elements of the atmosphere, little is known. It exists in close combination with nitrogen and was not discovered until 1894.

Ozone.—Ozone is a form of oxygen. It averages in the country about $1/700{,}000$ part of a given volume of atmosphere. In crowded cities little or none is found. Ozone is even more active than oxygen in its union with other substances. The dust which all rooms contain quickly exhausts the supply of ozone. Its presence is a guarantee that the air is free from organic impurities and decay.

Dust and Other Impurities.—Dust and smoke are the most important of the organic impurities of the atmosphere. Near the surface of the land dust is everywhere present, and it is even carried far out to sea. Vessels on the Atlantic, west of Sahara, have had their sails reddened by dust carried out by the trades. Admit a ray of sunshine into a darkened room, and observe the countless dust particles dancing along its path. Now set the air in rapid motion and their number is greatly increased.

The air currents are constantly gathering dust from the earth's surface, and carrying it before them, depositing it perhaps many miles from the place where it was picked up. In some places, as in Central Asia, caravans have been destroyed and whole cities buried by this wind-borne sand.

Active volcanoes send great quantities of dust into the atmosphere. Most of this settles in a comparatively short time, in the vicinity of the volcano from which it came. Some of this dust encircles the globe. Of the dust hurled into the air at the time of the great eruption of Krakatoa (1883) particles remained in the atmosphere for two or three years.

From every chimney in our cities clouds of smoke are rising. In the case of great manufacturing cities this smoke often literally darkens the sky. Because of this, a clear view of a manufacturing center can rarely be obtained from the tops of any of its tall buildings. The dust which settles in the City of London in a single month amounts to several tons to the square mile.

These dust particles cool rapidly, and hence each serves as a center for the condensation of moisture. Dust is an important factor in causing rain. Because of dust, fog and cloud become more prevalent in a great industrial center than they would otherwise be. London furnishes the most striking illustration. This great city has on the average but fifteen hours of sunshine during either January or December; a state of affairs almost inconceivable to us. Greenwich, just outside, has forty-five hours of sunshine during each of these months, while Kew, a little farther away, has seventy-one hours. From 1871 to 1890 there was an increase in the number of fogs in London amounting to 50 per cent. Very recent investigations seem to indicate that foggy days are now decreasing in number.

During dense fogs the streets are dark at midday, therefore streets as well as homes, schools and places of business must be lighted. This means a great expense for light, added expense for fuel, the depression which accompanies absence of sunshine, discouragement because of impossibility of keeping things clean, increase in accidents, disease and death. Post-mortem examinations of the lungs of persons who have spent their lives in London have shown them clogged with soot.

The most important of the organic impurities are the bacteria of animal life, such as the germs of disease. These the winds waft to all parts of the world. In addition, there are the vegetable forms, such as the molds or fungi, which produce the fermentation and decay of organic matter. The flavor of fruits and the luxuriant growth of leguminous crops is due to certain bacteria. Experiments carried on in France showed 345 bacteria per cubic centimeter in the country and 4,790 in the heart of Paris. Air at high altitudes, as well as that over the ocean, contains few bacteria. Houses should be well ventilated and should freely admit sunshine, as under these conditions bacteria are not numerous.

Temperature.—At a distance of about 93,000,000 miles from the earth is the sun. This distant incandescent globe is the controller of our temperatures. If the light of the sun were cut off at this instant we would still continue to enjoy the sunlight for eight minutes. In other words light, traveling at the enormous speed of 186,000 miles per second, requires eight minutes to reach the earth. This gives some idea of the vast distance of the sun from the earth.

Every form of plant and animal life depends upon the sun for existence, and all life constantly expresses the relationship between itself and this glowing sphere. With the change in the angle at which his rays fall upon the earth, we change from the lightest garments to furs, from life out of doors, under the trees and beside the streams to life within walls beside a fire. A change in temperature of but a few degrees often means a loss of thousands of dollars. The effect of a mere mass of clouds obscuring the sun for a single day is reflected in our daily lives.

Here it will be well to recall the fact that heat is not a substance, but a form of energy, and that it is the result of the movement of the molecules of which all bodies are composed. The degree of heat we express in terms of temperature.

Heat is transmitted in a number of ways. Radiation implies transmission from a hotter to a colder medium. At night the earth radiates heat to the colder atmosphere. Conduction implies the transmission of heat from one part of a body to another, as from end to end of a hot iron rod. Convection implies movement of the molecules in the body itself, as in the circulation of the atmosphere. Heat is also reflected, as from the surface of a body of water.

The temperature of the sun at its surface is variously estimated at from 6,000° to 7,000° F. and the temperature of the interior is no doubt much higher. Could we build up a column of ice two miles in cross-section, and reaching to the sun, the total amount of heat given off by the latter would be sufficient to melt it in one second. The heat received on one square mile by vertical rays would raise 750 tons of water from freezing to boiling in one minute. Great as is the amount of heat given off by the sun, the earth receives only about 1/2,000,000,000 part. The remainder, so far as we are concerned, is lost.

It is believed that the contraction of the sun is the chief source of its heat. According to Helmholtz, an annual contraction of 250 feet in the sun's diameter would be sufficient to account for the heat given off in the same time.

The energy given off by the sun is called *insolation*. It is not transformed into heat until it strikes the surface of the earth. It is then radiated and reflected into the atmosphere. The atmosphere is thus warmed from the bottom, which accounts for its being colder at high altitudes than it is near the earth's surface. Mountains are colder than the valleys below them because there is comparatively little land at high altitudes to radiate and reflect heat and because dust and water vapor favor the absorption of heat. Dust is not usually abundant in mountainous regions and the capacity of the atmosphere for water vapor rapidly decreases with decrease in temperature. On the average, temperature falls 1° F. for each 330 feet of ascent. This is about three hundred times as rapid as the fall in temperature with the increase in latitude. Recent studies indicate that beyond the altitude of about seventeen miles temperature remains fairly constant.

Insolation depends upon the angle at which the sun's rays strike the earth, the distance of the earth from the sun, and the duration of sunshine. The greatest amount of insolation received by a given place during a period of rotation is at noon, while the greatest amount received during a period of revolution is on June 21st (for the northern hemisphere). As is well known, the earth is nearer the sun in January than in July, and the actual amount of insolation received in January is about 7 per cent. more than that received in July. During the summer in high latitudes, the great length of the day is a marked compensation for the low angle at which the sun's rays strike the surface of the earth. On June 21st the insolation at the North Pole is 20 per cent. greater than that at the equator on September 21st or March 21st. The possible duration of continuous sunshine varies from twelve hours at the equator to six months at the poles.

There is no direct relation between insolation and temperature, as is shown by the fact that places on the same parallel have very different temperatures. There is a regular diurnal variation in temperature, due to the rotation of the earth; a seasonal variation, due to revolution; a latitudinal variation, due to the varying angle at which the sun's rays strike the earth, and an altitudinal variation, due to the fact that the atmosphere is warmed from the bottom.

Pressure.—It is not difficult to realize that a column of iron or stone, one inch in cross-section, and extending from the surface of the earth to a height of, say, one hundred miles, would have a tremendous weight. It *is* difficult to realize that a column of atmosphere of the same dimensions has weight. Torricelli in 1643 was the first to prove this.

The atmosphere, like everything else, is acted upon by gravity, which draws it toward the center of the earth. The measure of this attraction as applied to the air is its weight, which at sea level normally amounts to 14.7 pounds per square inch. The reason why the mercury in a barometer stands lower on a mountain than at sea level is not simply because the air is less dense at high altitudes, but chiefly because, as greater and greater altitudes are reached, there is more and more of the atmosphere left below and less and less to weigh. According to Bonney the average reading of the barometer at the City of Mexico is 23.07 inches; at the top of Pike's Peak, 17.75 inches, and on the summit of Chimborazo, 14.11 inches.

Pressure is vitally related to human life. Most persons experience considerable difficulty in ascending to great altitudes, while many cannot live at altitudes of a few thousand feet. A large part of the population of the earth is found below 1,000 feet in altitude. Roughly, the altitude at which "mountain sickness," as it is called, is experienced, is from 3,500 to 4,000 meters, or about 13,000 feet. There are, of course, exceptions to this. In Bolivia there is a colony of miners at an altitude of 16,000 feet, while the Indians who bring sulphur from the crater of Popocatepetl live at altitudes varying from 13,000 to 16,000 feet, and in both cases the people seem well and strong. Observation, however, shows that those who live at great altitudes are usually lacking in vigor.

Those who ascend lofty mountains are generally afflicted with mountain sickness whether they exercise or not. The trouble seems to be due to a decrease in oxygen in the blood. Examination of the blood in such cases shows a lack of the red coloring matter.

It is atmospheric pressure that lifts the water from a well in which an ordinary pump is used. A cubic inch of water weighs .036 of a pound, and 14.7 divided by .036 gives 34, or the length in feet of a column of water that can be sustained by atmospheric pressure. Therefore a simple pump cannot be used in a well that is more than thirty-four feet deep. Atmospheric pressure is utilized in connection with bicycles, automobiles, air-brakes and vacuum cleaners.

The relation between atmospheric pressure and cooking is interesting, although not very important. It is a common saying that water will not boil on high mountains. As a matter of fact water boils more readily on the summit of a lofty mountain than it does in the valley below. Owing to decreased pressure the water boils at a lower temperature, hence it is difficult to cook certain foods, such as beans and potatoes. It takes about twice as long to cook potatoes at an altitude of 10,000 feet as at sea level.

The Origin of the Atmosphere.—Vast as is the atmosphere, it is believed by some to be but a very small part of the original mass. It is held that all the planets were once in the form of a great nebula which rotated anti-clockwise. Through countless centuries most of this mass gathered about a common center, thus forming the sun. Smaller portions, in a similar way, produced the other heavenly bodies. This gives some meaning to the fact that all these bodies, so far as known, rotate and revolve in the same direction.

The original nebula was, of course, at a very high temperature, for all substances found on the earth were then in a gaseous condition. As the temperature of space is exceedingly low, about −459° F., the earth has been, and is, steadily but slowly cooling. As the cooling went on certain elements were precipitated. The first were those having a high condensation temperature. This process would place the rocks just where we find them—in the center. Water, having a very low temperature of condensation, was not precipitated until much later, and therefore we find it surrounding the rocks. How many ages passed before the first rain reached the earth no one can tell, but that event was most important in the evolution of the world. Air, requiring a temperature of −328° F. for its condensation, has not yet been liquefied in nature.

This historic atmosphere was hot, vaporous, acidic and dense. The water alone increased its weight about one hundred and fifty times, while the material which at a later time took the form of rocks added much more to its weight. This attempt to explain the origin of our atmosphere, its conditions and many other facts, is known as the *Nebular Hypothesis*.

Future of the Atmosphere.—It has been shown that the atmosphere has undergone great changes in the past. Is it now changing? What will be its condition in the future? It seems reasonable to believe that the sun is slowly decreasing in temperature, and as the temperature of the atmosphere is controlled by the sun, we may conclude that the atmosphere is gradually getting colder.

The gradual abstraction of oxygen from the atmosphere through the process of oxidation will in time so reduce the amount of this gas in the atmosphere that life as we now know it cannot exist. As the earth cools, more and more moisture will be taken from the atmosphere, and less and less returned to it through the process of evaporation. As the nitrogen does not readily unite with other elements there may be comparatively little change in that.

STUDIES

What proof that the atmosphere penetrates the ocean? Explain how shore forms are to a certain extent the result of the work of the atmosphere? Why do quarrymen often reject the surface rock? How can the altitude at which a meteor is seen be determined? Does the earth radiate heat during the day? Is it possible that the surface temperatures of the earth are in large part due to the heat of the interior? Why do not places which receive an equal amount of insolation register the same temperature? Give examples of radiation, conduction and convection. Why do people, when at the seashore, sunburn so readily? Why is white clothing so appropriate in hot weather? Why is mercury used in thermometers? Does the bore of the mercury column affect the height of the column? Explain the application of atmospheric pressure to the use of air brakes. Is it probable that the pressure of the atmosphere has always been about as it is at the present?

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CHAPTER IV

General Movements of the Atmosphere

Cause of Circulation.—It was said of old, "The wind bloweth where it listeth, and thou hearest the sound thereof, but canst not tell whence it cometh and whither it goeth."[1] Much has been learned regarding the winds since these words were spoken and today the cause and the course of atmospheric movements are quite well understood.

Here, as elsewhere, we should draw upon our actual experience in our efforts to advance our knowledge. You have observed many times, in opening a door connecting a warm and a cold room, that the air moves into the warmer room. Step into a cave or a tunnel on a warm day and you feel the air blowing outward against your face. When there is a fire in a room the air moves toward it from all parts of the room. The movement is well shown by a bonfire. The air moves in toward the fire from all sides and ascends in a column above it as is shown by the movement of the smoke, flame and small pieces of partially burned material. We may say that *difference in temperature is a cause of atmospheric movement.*

As air warms, it expands and therefore a given volume exerts less pressure than it did before being warmed. The colder air surrounding a heated area, exerting greater pressure, volume for volume, than does the warmer air, pushes the latter out of the way. This explains the rising of the air over a bonfire. We see then that the surface movement of the air is toward areas of decreased pressure. *Difference in pressure is another cause of atmospheric movement.* Areas of low pressure are practically always areas of high temperature. Some exceptions will be noted later.

Isotherms.—Were the angle at which the sun's rays strike the earth the only factor in determining temperature, all places on a given parallel would register the same degree of heat. This is far from being true, however. A line connecting places having the same average temperature for a given period is called an *isotherm,* or an *isothermal line,* from the Greek *isos,* equal, and *therme,* heat. As land heats and cools more rapidly than does water, that is, as it is a better conductor,

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[1] Bible. John 3:8.

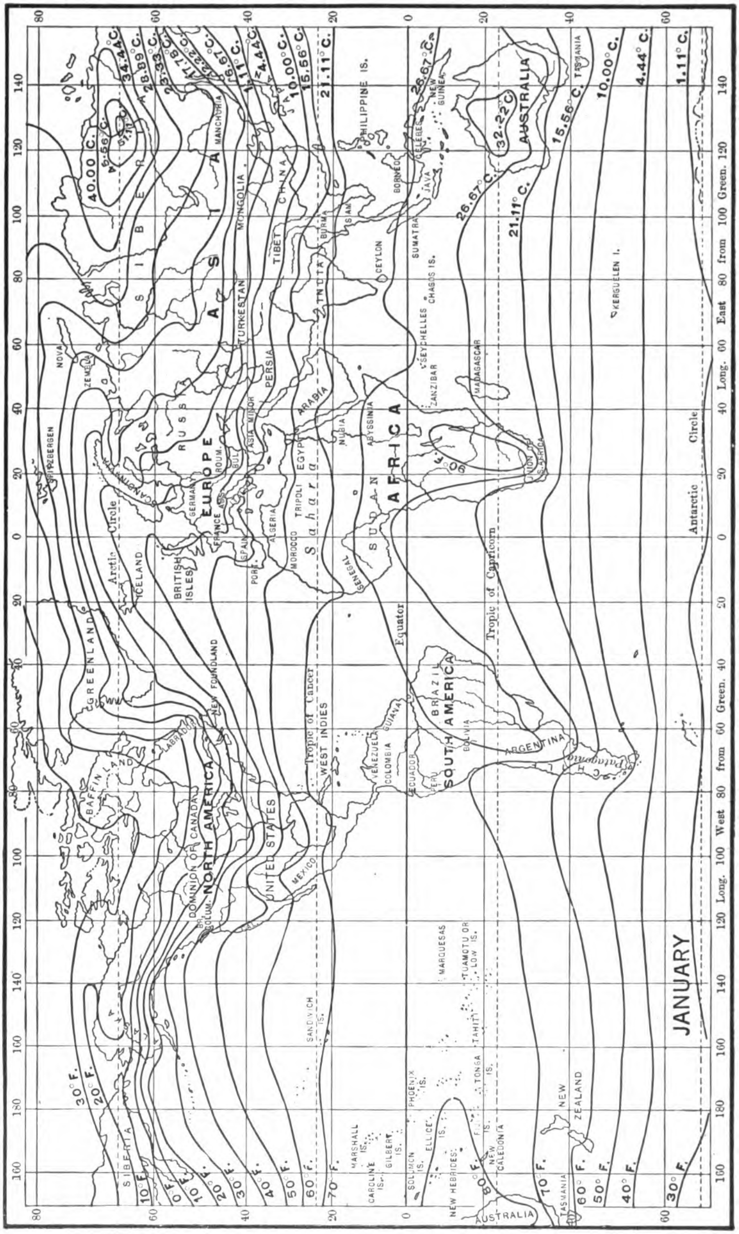

FIG. 12.—January isothermal map of the world.

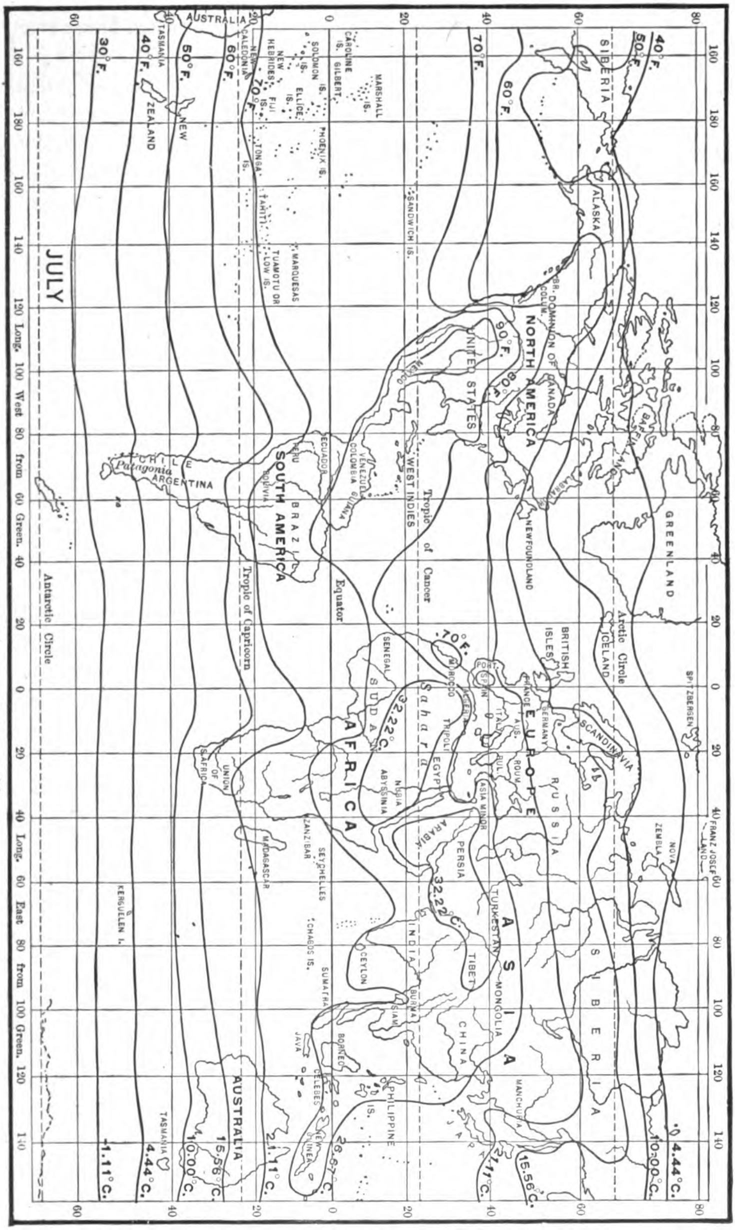

FIG. 13.—July isothermal map of the world.

isothermal lines are much more irregular upon the land than they are upon the ocean.

An annual isothermal chart shows the mean annual temperatures of countless places, but it tells comparatively little regarding the climates of these places. By means of a January and a July isothermal chart the seasonal ranges in temperature may be ascertained. The isotherms on a daily weather map show the location of the warm and cold areas for the given day.

Isobars.—Lines connecting places having the same barometric pressure for a stated time are called *isobars,* from the Greek *isos,* equal, and *baros,* weight. The average height of a column of mercury which can be sustained by atmospheric pressure at sea level is 30 inches. Therefore the average reading of the barometer at sea level is 30 inches, or 76 cm. Isobaric lines represent isobaric surfaces.

The atmosphere always moves from areas of higher to areas of lower pressure. The greater the difference between the pressure of two adjacent areas, the more rapid will be the resulting movement of the atmosphere. The difference in pressure is known as *barometric gradient.* A daily weather map shows the location of the high and low pressure areas for the given day.

Trade Winds.—As the equatorial belt is permanently warmer than the temperate zones, we have a permanent or constant movement of the atmosphere toward the equator. This movement, which takes place from both the north and the south sides of the equator, is known as the trade winds.

For hundreds of years information concerning the winds on this belt has been accumulating. Much of this knowledge is represented by Fig. 16. From about the thirtieth parallel north and south of the equator there is a strong and steady movement of the atmosphere equatorward. Strictly speaking, the margins of these wind belts are not parallel circles and they are subject to much fluctuation. They shift poleward during the summer and equatorward during the winter. There is less change in position over the ocean than there is over the land. Owing to the deflective influence of the earth's rotation these winds blow from the northeast in the northern and from the southeast in the southern hemisphere.

After Columbus left the Cape Verde Islands on his memorable first voyage he had but to persist in his effort to find land by sailing westward in order to make its discovery certain. Day after day beneath bright skies his ships were driven before this steady wind, which followed the same general course before the dawn of creation.

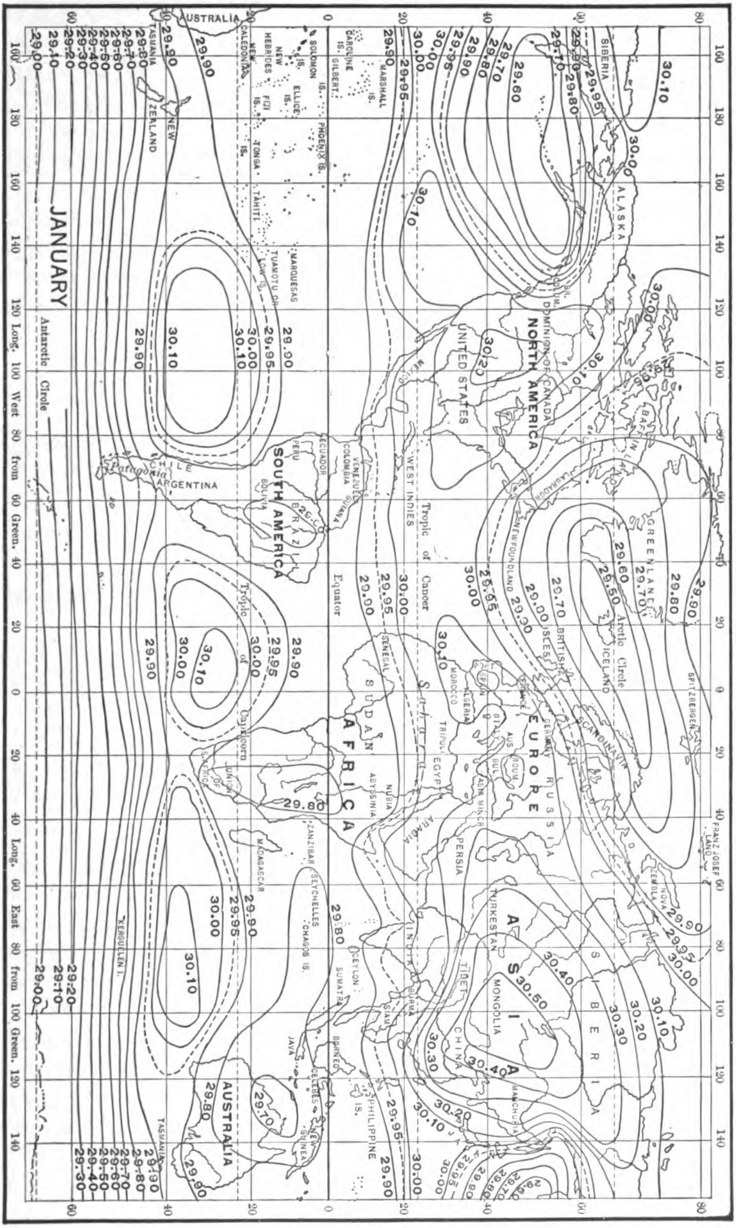

FIG. 14.—January isobaric map of the world.

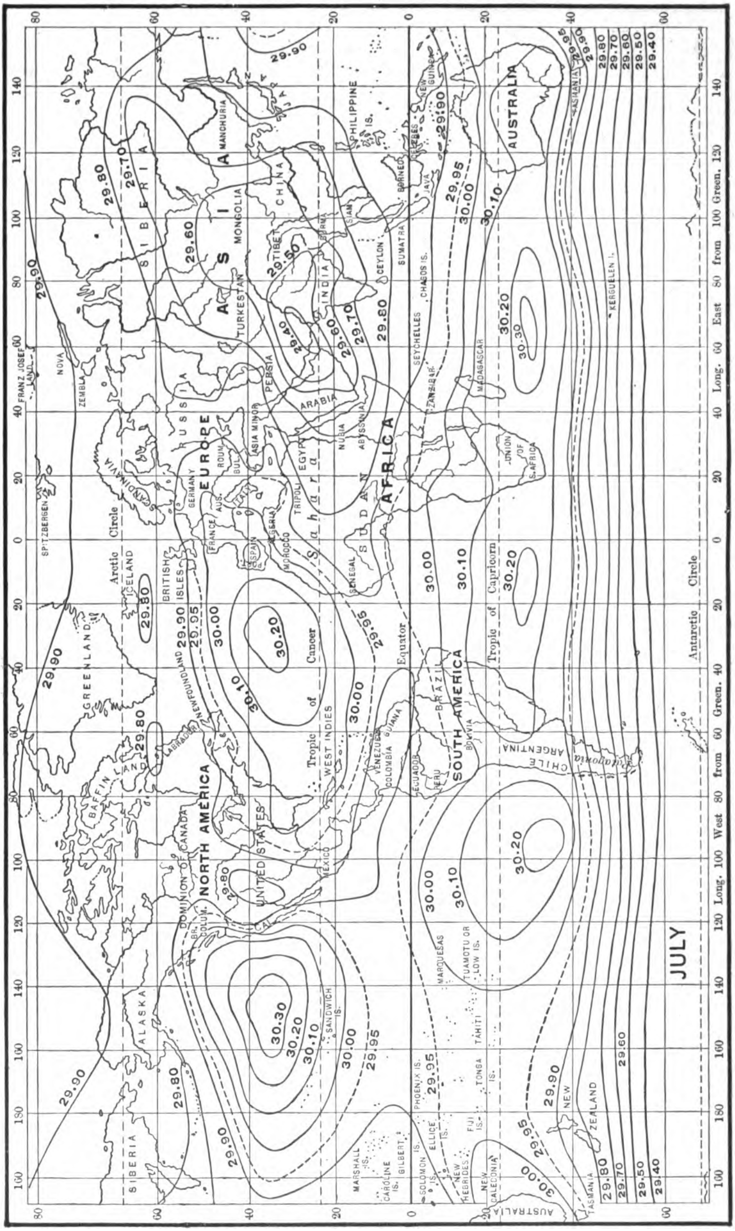

FIG. 15.—July isobaric map of the world.

That this wind was to waft them to certain death rather than to a wonderful discovery, the sailors of Columbus were convinced. The constancy of these winds is illustrated by the fact that in the West Indies they prevail for 79 per cent. of the year, and cause all vegetation to lean to the westward.

Doldrum Belt.—The northern and southern divisions of the trades meet in a belt which encircles the earth on either side of the equator, but lying chiefly to the north of it, because of the greater amount of land in the northern hemisphere. This is known as the *doldrums*, or belt of calms. It is a calm belt in the sense that there is little horizontal movement of the atmosphere. The heated air is

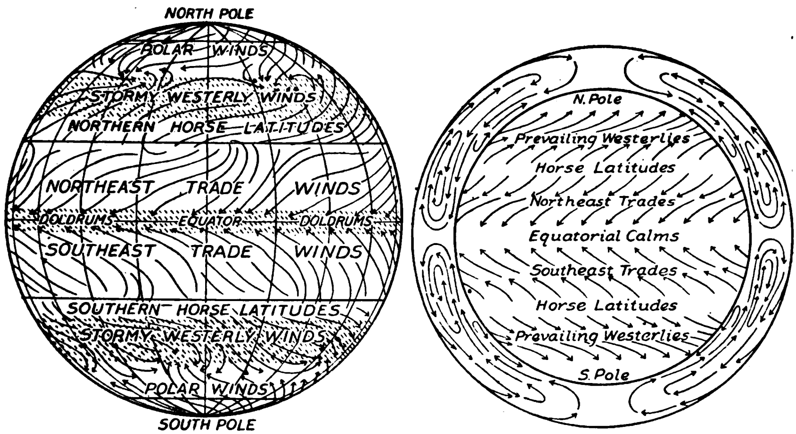

FIG. 16.—The prevailing winds.

steadily rising, being displaced by cooler, heavier air. Vessels are often becalmed in trying to cross the doldrums.

Within this belt lies the *thermal equator*, or line connecting the points which permanently have the highest temperature. The thermal equator, the doldrums and the trades, following the apparent movement of the sun, shift northward during summer in the northern hemisphere and southward during winter in the same hemisphere.

Anti-Trades.—The air that rises over the belt of calms cools as it ascends, and divides into two streams, one flowing northward and the other southward. Only upon the tops of the most lofty mountains are they felt, although drifting clouds show their existence. At about 30 degrees north and south of the equator these air currents descend, producing what are known as the horse latitude belts. While the doldrums is an area of low pressure, the horse latitude belts are high pressure areas, for here relatively cold air is settling.

Westerlies.—From about the parallels of 30 degrees north and south of the equator to the poles the prevailing wind is the westerly. In accordance with Ferrel's Law these winds blow from the southwest in the northern, and from the northwest in the southern hemispheres. They lack the constancy of the trades. In Boston they prevail for 20, in Detroit for 31 and in San Francisco for 38 per cent. of the time.

As the westerlies sweep poleward they acquire a spiral movement about either pole known as the circumpolar whirl. Although the temperature is very low, these are areas of low barometric pressure. It is believed that the conditions are analogous to those in a wash basin when the water is caused to whirl about the opening in the bottom. The whirling air, rising, reduces the pressure. André, the ill-fated explorer, trusted to this air current to bear his balloon directly to the north pole. As he never returned from his voyage, his exact fate is unknown.

The air, rising above the poles, moves equatorward and settles to the surface in the horse latitude belts. From this latitude to the equator it enters into the regular trade wind. Thus we have a complete circulation.

The Monsoons.—A given amount of insolation applied to equal areas of land and water will raise the temperature of the former about four times as much as that of the latter. During the summer the temperature of the land is higher than that of the water, as the isothermal charts show. There is, at this season, a marked barometric gradient between the water and the land, and as long as this condition exists the air moves toward the land. The great peninsula of India is, during the northern summer, an area of low pressure, while during the winter it is an area of high pressure.

Seasonal changes in the direction in which the atmosphere moves result from these seasonal changes in temperature and pressure. These periodic movements of the atmosphere were long ago given the name of *monsoon*, meaning season. During the summer the barometric gradient is so marked that air is drawn from south of the equator. As it travels north of the equator the influence of the earth's rotation deflects it to the right so that it becomes a southwest wind.

The summer moonsoon causes a very heavy rainfall on the western slope of the Western Ghats and a much heavier rainfall on the southern slope of the Himalayas, amounting in one district to about

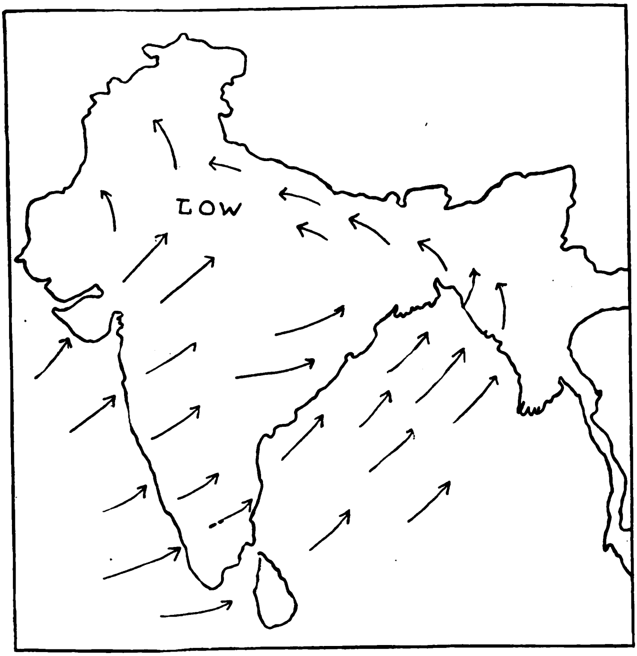

Fig. 17.—Winds and pressure in India in July.

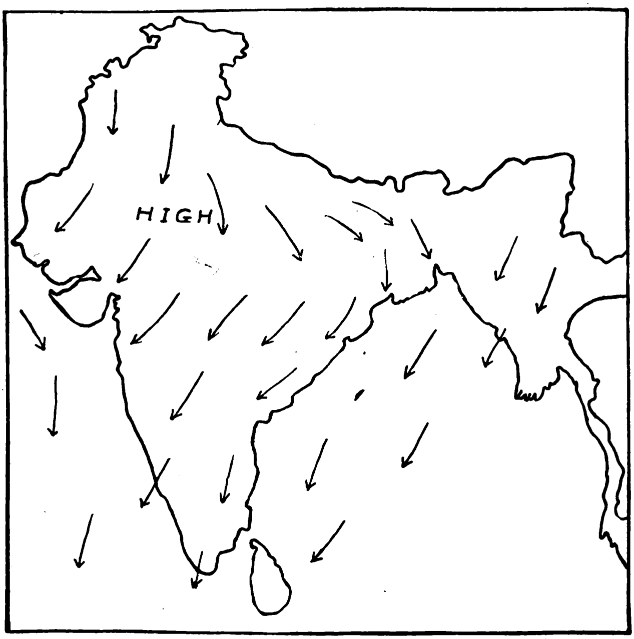

Fig. 18.—Winds and pressure in India in January.

forty feet per year, and a maximum of fifty feet has been recorded. India's 300,000,000 of people are in large measure dependent upon the summer, or *wet*, monsoon. While India is the great monsoon region of the world, these seasonal winds are well developed along the coast of Australia, the Gulf of Guinea and in Mexico.

Land and Sea Breezes.—Close to the margin of the sea there is a diurnal change in temperature and pressure. This gives rise to diurnal changes in the movements of the atmosphere. During the hours of sunshine, the low pressure is upon the land and this causes an expansion of the air near the surface of the land. This expanded air is forced upward and flows out to sea as an upper current. This increases the pressure locally over the ocean and therefore there is a surface movement of air toward the land—the *sea breeze*. During the night low pressure is transferred to the ocean and the air flows from the land. This movement is the *land breeze*.

The land and sea breezes are purely local, although in places they are felt at least fifty miles from the coast. The greater the diurnal range in temperature the greater their strength. The sea breeze is one of the powerful factors in producing the very delightful climate of the coastal regions of California.

Along the shores of our Great Lakes there are similar diurnal movements. Twenty miles west of Chicago the lake breeze is often very noticeable on a hot afternoon. As it beats back the prevailing west wind the temperature suffers a most remarkable drop. Its influence is seldom felt until after noon.

Mountain and Valley Breezes.—There is another diurnal change in atmospheric movements of some importance in mountainous sections, namely the mountain and valley breezes. As the lower layers of the atmosphere in the valley are warmed during the day the isobaric surfaces rise, producing at their outer edges a barometric gradient toward the mountains. This causes a well-marked current of air up every valley and canyon. From a mountain top one may often see during the morning hours a great billowy sea of fog covering the valley. As the temperature rises the fog rolls toward the mountains, beating against the foothills and sending white streams drifting up each canyon. As the fog reaches the mountain top it is dissipated in the expanded air.

During the night the cold, dense air slides from the mountains down into the valleys. In this case the descent is aided by gravity and by the expansion of each valley at its lower end. The mountain breeze is therefore usually much stronger than the valley breeze.

This movement of the atmosphere has a tendency to prevent frost on the foothills and to cause it on the lowlands. The rapid drainage of the air in the first case, and its relative stagnation in the second, explains this. Upon these so-called frostless areas certain crops can be grown more successfully than in the valleys.

The classes of winds treated above are rather constant or else occur at stated intervals. There is another class of atmospheric movements which are in no strict sense regular in their occurrence, although they are governed by well-known laws. These movements, which are known as periodic winds or storms, are dealt with in the next chapter.

Frank Demster Sherman says of the winds:—

> The steady wind that fills the ship's white sail,
> And turns the mighty millwheel when it blows,
> Once breathed a love song to the nightingale,
> And wafted him the perfume of the rose.
> Let him who seeks a godlike man to find,
> Think of the wind, and seek its counterpart.
> The tempest's strength, matched by a noble mind,
> The zephyr, by a pure and gentle heart.

STUDIES

How do the isotherms in the southern hemisphere differ from those in the northern hemisphere? Explain. Upon what annual isotherm is your town situated? Do *all* places on the same annual isotherm have the same average annual temperature? By means of the annual isobaric chart locate the great high and low pressure areas. Explain their location and their seasonal movement. Why is not the thermal equator parallel to the geographic equator? The western portions of large cities in the temperate zone are usually the most desirable as residence sections. Why? What is the relation between the trades and the monsoons? Explain why the winds are deflected by the earth's rotation. Make a list of the ways in which the winds are related to man.

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CHAPTER V

Storms

Any one who has observed the flow of streams knows that occasionally eddies form in them and go whirling along with the current. In a somewhat similar manner eddies form in the great atmospheric currents and are borne forward by the general movement. These whirls are atmospheric disturbances to which the general name of *storm* is applied. As indicated below, storms are of various kinds. Weather changes are in large measure due to the occurrence and migration of storms.

CYCLONES

A temperate latitude cyclone, or as it is usually called, a cyclone, is a great whirl or eddy varying from 200 to 2,000 miles in diameter and averaging perhaps three miles in depth. Cyclones are thus only discs, yet the volume of air disturbed is enormous. For example, one edge of a cyclone may rest on the Pacific Coast of the United States and the other over the Mississippi River.

A cyclone is an area of low pressure. It is accompanied by clouds and generally by precipitation. Being an area of low pressure, the atmosphere flows in toward the center of the area as it moves forward. It is evident then that on the front or east side of a cyclone the air moves in *against* or in opposition to the forward movement. On the west side the reverse is true.

Cyclone Tracks.—Cyclones follow rather definite tracks across the temperate zone and these tracks are known and charted. These storms originate both upon the water and the land. Those that move from the Pacific Ocean to North America generally strike the coast in the neighborhood of British Columbia or Puget Sound. Their course is then southward and eastward over the Great Lakes and down the St. Lawrence Valley unless they die out earlier in their course. Some cross the Atlantic and northwestern Europe, and because of lack of moisture, die out in the central part of Russia.

Temperate latitude cyclones occur at all seasons of the year. The blizzards of winter and the rain storms of summer are cyclones. They are somewhat more numerous and more violent during the winter than during the summer months.

Rate of Movement.—The progressive or forward movement of cyclones is not rapid, averaging in the United States about 30 miles per hour, or 700 miles per day. Roughly speaking, one of these storms crosses the continent in about the same time required by a passenger train. This makes it possible to follow the progress of storms, and by means of telegraph, telephone and cable service, to report upon their conditions and movements. The whirling movement of the storms is much more rapid than the forward movement.

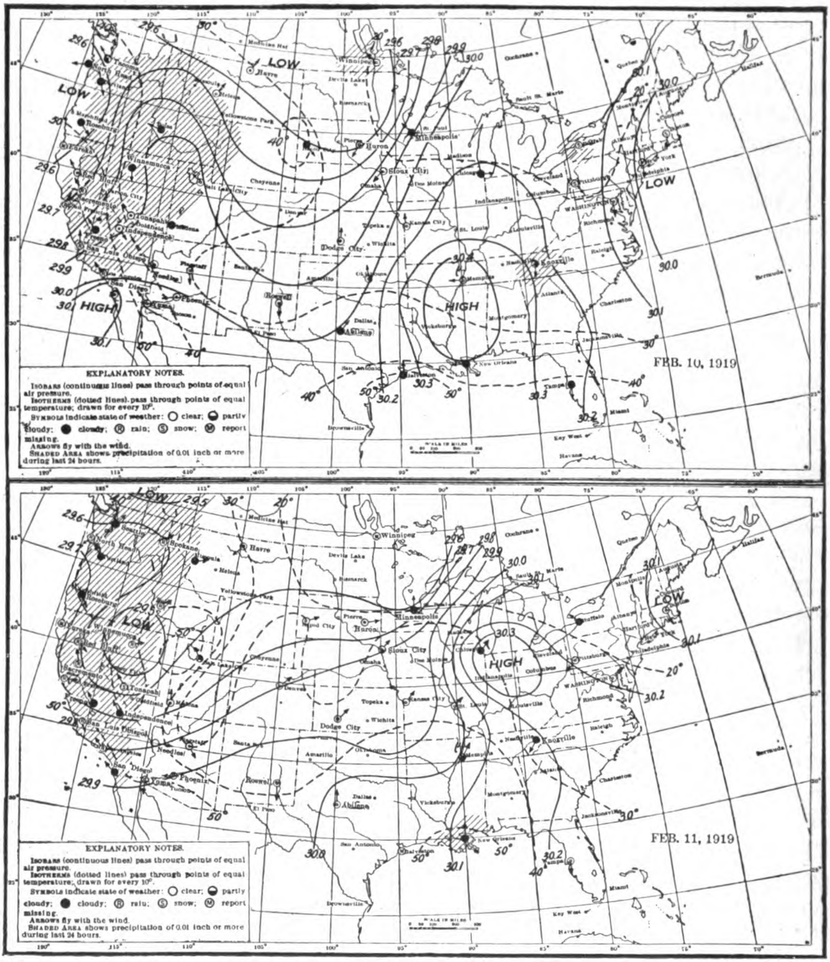
Clouds and Precipitation.—In the case of a cyclone 1,000 miles in diameter it will be seen that the air that moves in from the south comes from warmer to cooler areas. The consequent lowering of the temperature as the air approaches the center of the disturbance causes the formation of clouds and usually leads to precipitation.

As a cyclone approaches an area the barometer falls, the humidity increases, the wind blows from some southerly quarter, and clouds and precipitation may be expected. As the storm recedes the sky clears, the pressure rises, and the temperature falls because the air is being drawn in from a northerly quarter. On the rear side the temperature is often 25° F. lower than it is on the front side of the storm.

Anticyclones.—The conditions in the atmospheric whirls that follow the cyclones are just the reverse of those that exist in the cyclones. In the central portion the air moves downward instead of upward. Along the surface the air moves outward in spiral form instead of inward. As already stated, the air is clear, cool or cold, and the pressure high. The whole disc whirls *with* instead of *against* the direction in which the hands of a clock move. For these reasons this disturbance is called an *anticyclone*.

Hot and Cold Waves.—Occasionally the areas of high and low pressure remain practically stationary for a time. When this is the case unusual weather conditions prevail. If in the summer there is a stationary high over our southeastern coast and a low in the northwest, the eastward drift of the low will be checked. Air will move from the area of high toward the area of low pressure, having its temperature constantly raised by the hot land over which it passes. This condition gives rise to a hot wave which continues until the high drifts eastward or dies out.

If on the other hand there is a winter low in the Gulf region and a high over the Rocky Mountains, it is evident that the air will flow down the barometric gradient toward the Gulf States. This will carry a cold wave across the central part of our country and into the South.



Courtesy U. S. Weather Bureau.

FIG. 19.—Progress of a temperate latitude cyclone.

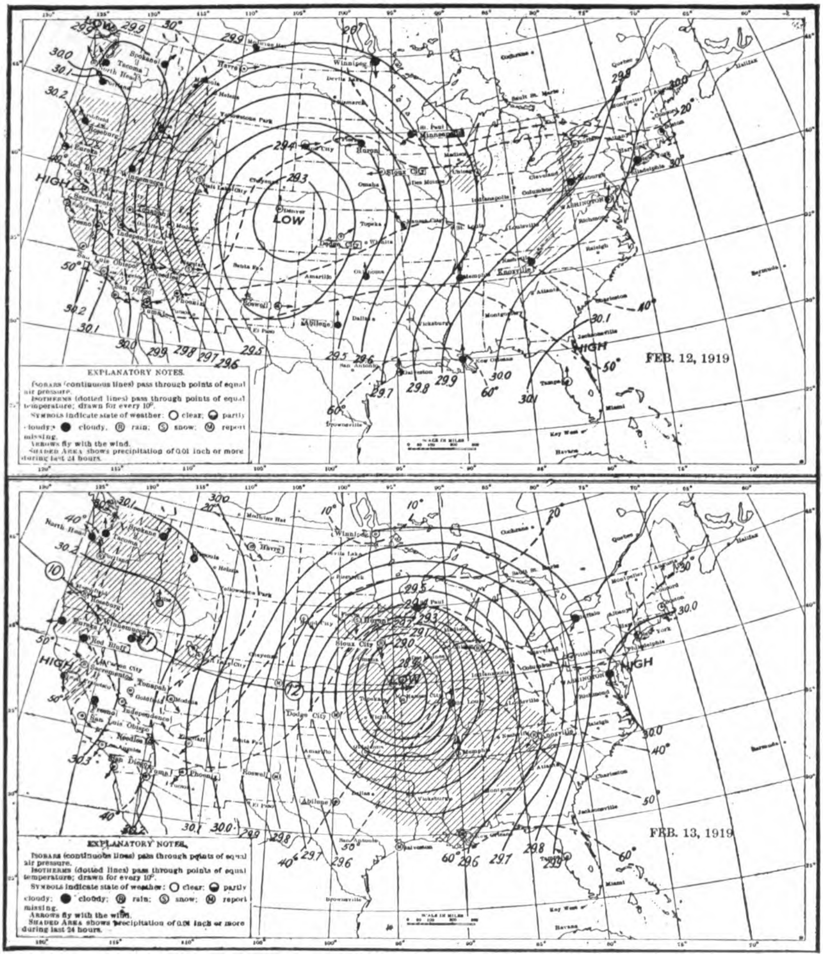


FIG. 20.—Same storm shown in Figs. 19 and 21.

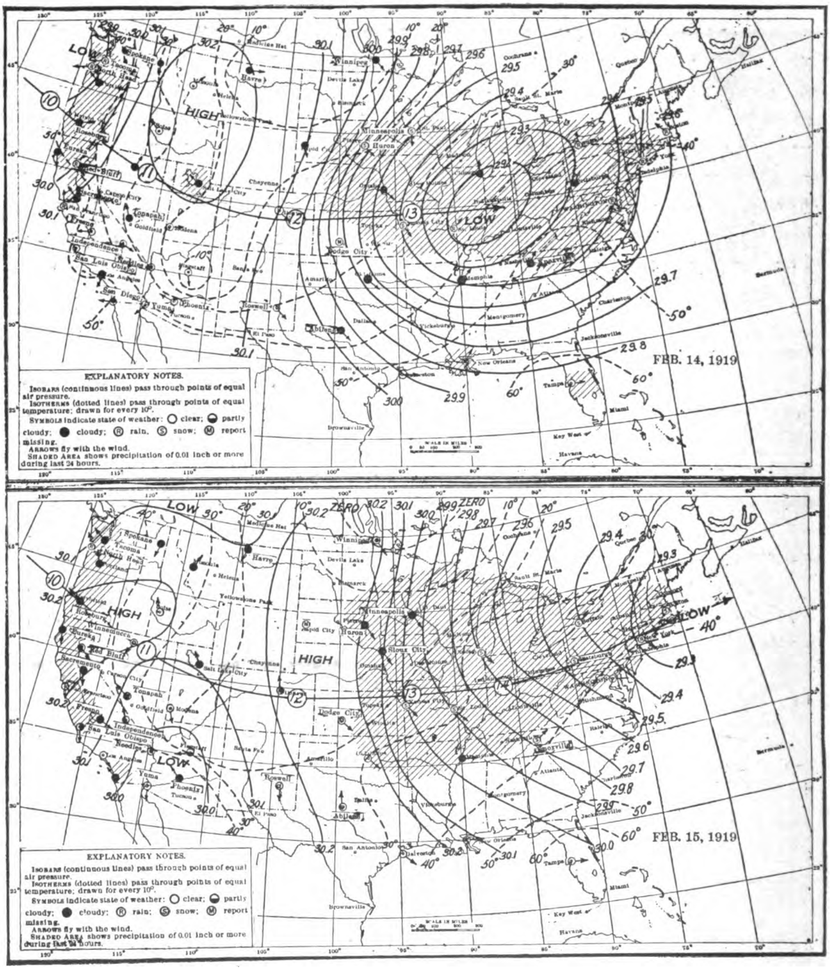


FIG. 21.—Same storm shown in Figs. 19 and 20.

HURRICANES

On Saturday morning, September 8, 1900, the City of Galveston was a thriving metropolis, full of life, hope and joy. When the light of Sunday, September 9, broke over the city, it revealed one of the greatest disasters recorded in human history. About one-half of the city was laid waste. Stores, residences, bridges, poles were floating in the streets or in the Gulf. In one district where on Saturday 20,000 persons had their homes, not a single building was standing. Fully 6,000 persons lost their lives during the brief space of one hour. This terrible havoc was wrought by a *hurricane* or, as such a storm is called in Asia, a *typhoon.*

From what has been said it might be inferred that this death dealing monster broke upon the city suddenly and without warning. Such is far from the truth. The approach of the hurricane was known for one week before it reached Galveston. Its progress was known, charted, and reported to the people from one end of the land to the other daily, while special reports and warnings were issued to all port cities. Moreover, the warnings issued by the Weather Bureau on that ill-fated 8th of September saved a vast amount of property and thousands of human lives.

Resemblance to Cyclones.—Hurricanes, like temperate latitude cyclones, are vast atmospheric whirls, having a progressive motion with the prevailing air movement in the tropical zone. They are like cyclones also in being areas of low pressure and in being accompanied by precipitation.

Place and Time.—Unlike cyclones, these storms originate on the ocean, although many of them are destructive along the margins of the land. They occur in the Pacific and in the North Atlantic, but are absent from the South Atlantic. The West Indies, the Philippines and the adjacent coasts of South America and Asia are frequently visited by hurricanes.

Hurricanes originate in the doldrum belt when it is farthest from the equator, and move with the prevailing wind, that is west, until they reach the latitude of 26° to 32° north, when they come under the influence of the earth's rotation and recurve to the northeast. While they occur at all times of the year, they are most frequent during the late summer and the autumn.

In speaking of the hurricanes of the West Indies, Professor Fassig says: "The geographic center of origin for the entire season is in latitude 20° north and longitude 73° west, or just off the northwest coast of Haiti. The average point of recurve is in latitude 28° north and longitude 82° west, or in the center of the Florida Peninsula."[1]

Area.—While the area covered by a hurricane is great, it is much less than that covered by a well developed cyclone, being from 100 to 500 miles in diameter. The depth may be as great as six miles.

Transmission.—The forward movement of hurricanes is not rapid. In the neighborhood of the West Indies it is about 14.7 miles per hour, while along the coast of Asia it averages but 8.5 miles per hour. At times this rate is exceeded.

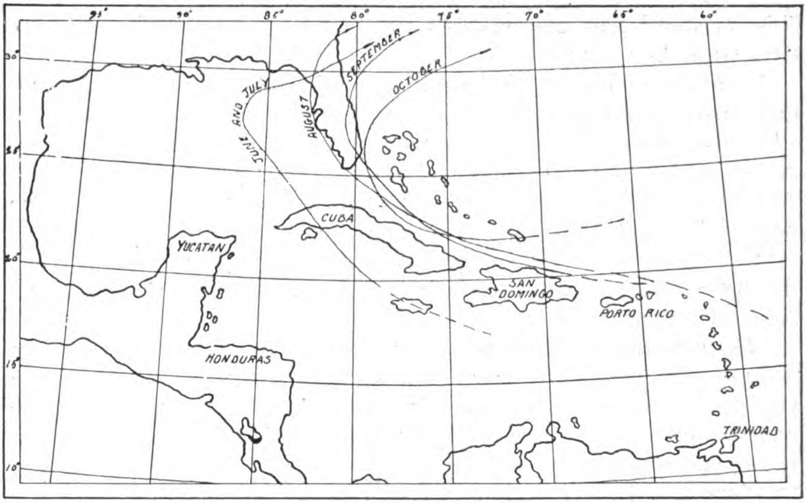


FIG. 22.—Average hurricane track for June, July, August, September and October. (From "Hurricanes of the West Indies," by Oliver L. Fassig, U. S. Weather Bureau Service.)

On September 27, 1882, a typhoon passed over Manila at the rate of 5 miles per hour. On October 1st it reached Japan and was moving at the rate of 33 miles per hour. On October 3rd, when some distance east of Japan, its rate was 51 miles per hour. The Oregon coast was reached by the storm on October 10th. It crossed North America, the North Atlantic Ocean and disappeared in the Baltic Sea on November 1st, having traveled a distance of approximately 14,000 miles and having lasted for thirty-five days. The average rate for the whole distance was 17 miles per hour. This includes one week

[1] Fassig, Oliver L.: "Hurricanes of the West Indies."—*U. S. Dept. of Agri. Weather Bureau Bull. X*, p. 9.

during which the storm was practically stationary in the North Atlantic. Though the progressive movement of a hurricane is not rapid, the velocities attained by the whirl are very high, sometimes reaching 100 miles per hour.

Description.—There are certain forerunners of these terrible storms which are well known to mariners. The weather conditions in the tropical zone are quite constant; clear sky, high temperature and steady east wind. At sea or along the coast the first indication of an approaching hurricane is a long, low swell. This is often many hours in advance of the storm and shows that the movement is transmitted through the water much more rapidly than through the air. Later indications are the appearance of lofty fleecy clouds known as cirrus clouds, the sultriness of the air, decreasing barometric pressure, and a lurid appearance of the sky at sunrise and sunset. A light wind springs up and steadily increases. Clouds grow thick and black. There is frequent and vivid lightning and the roll of thunder. The wind increases to a gale, the rain falls in torrents, and the barometer drops rapidly.

Presently the storm gives place to a comparative calm. The sea continues rough although the wind has died down. The rain ceases, the clouds break away, and the blue sky or the stars may be visible. This condition may last for a few minutes or for an hour or more. The calm area is known as the "eye" of the storm, and it varies from 10 to 30 miles in diameter. When the eye has passed over, the storm begins again with as much violence as before.

As the air is being drawn in from all sides toward the vortex it sometimes happens that vessels caught in it are whirled round and round until they sink. Oil is often allowed to drip on to the water from bags hung over the vessel's side. This has the effect of calming the waves because there is less friction between the wind and the film of oil which forms upon the water than there is between the wind and the water.

Tidal Wave.—When a hurricane reaches the coast, the wave piled up by its force is greatly increased in height on account of the friction on the floor of the ocean. If the coast is low this great wave, improperly called a tidal wave, may rise to a height of many feet and sweep everything before it. It was such a wave that was responsible for most of the loss of property and life at Galveston. Other very destructive waves have visited our Gulf coast. The densely populated delta of the Ganges has several times suffered as a result of tidal waves produced by typhoons, and the same is true of the coast of Japan.

The energy developed by one of these storms is beyond comprehension. This energy is, in large measure, drawn from the process of condensation. The rising air cools at the rate of 1° F. to 330 feet of ascent. This cooling soon produces condensation and an immense amount of heat is liberated. It has been estimated that a hurricane 100 miles in diameter and one mile high weighs as much as 500,000 six-thousand-ton ships. The energy required to drive such a mass over the surface of the water is enormous.

Cause.—During the northern summer the thermal equator and the doldrums move northward in response to the apparent northward march of the sun. Day after day the warm sunshine beats down upon the water, and a large part of the heat is given to the layer of air immediately above it. Evaporation is rapid, hence the humidity of the air is steadily rising. There is little to disturb this atmospheric condition, for the air is calm.

We have, then, warm, moist, light air lying beneath the cooler, drier and heavier air. This is an unbalanced condition known as *unstable equilibrium.* Occasionally the warm air appears to force an opening through which it escapes above, and down which the heavier air from above rushes. The whirl thus set up travels with the prevailing wind, and lasts until balance is once more restored.

A large volume of cold water is transferred from the Antarctic to the South Atlantic Ocean and along the west coast of Africa. Probably this is the reason why the doldrums move but a short distance into the South Atlantic. In this ocean, then, there are not the favorable conditions for the development of tropical cyclones—that is, calm areas with high temperature, low pressure and great humidity—which exist in the tropical portions of the other oceans.

The Galveston Hurricane.—In order to get a more definite idea of one of these storms, let us study the Galveston hurricane of September 8, 1900. On the afternoon of the 6th of September the barometer began to fall, and continued to fall until the storm had passed. On the morning of the 8th the tide was unusually high, and this fact was at once telegraphed to Washington. All day Saturday, September 8th, the Weather Office kept a man at the telephone sending warnings to all parts of the city, to adjoining towns and to plantations. Dr. Cline, the official in charge, made many trips to different sections of the city, personally urging the people to move their goods and to go to the higher ground.

The progressive motion as the storm passed over Galveston was only about 8 miles per hour. The whirling motion was, however, terrific. At 6.15 P. M. the anemometer registered a speed of 84 miles per hour for a period of five minutes, and 100 miles per hour for two minutes. The instrument was then blown down. The estimated velocity of the wind at a later time is much higher than this. This is not the greatest wind velocity ever recorded, for at Point Reyes Light, on the coast of California, velocities as high as 120 miles per hour have been recorded.

The barometric pressure at Galveston at 8.30 on the evening of the storm was 28.48, which is a very low reading, although in the Porto Rican hurricane of August 8, 1899, a pressure of 27.15 inches was recorded.

The work of the Weather Bureau at this time furnished convincing evidence of its great value, and was commented on by papers in all parts of the United States. Storm warnings were displayed at all sea ports, and even at lake ports as the storm moved northward. So great was the confidence of sailing masters in the predictions of the Weather Bureau that few ships put out to sea, and consequently the loss of life and property upon the water was very slight.

Geography of Galveston.—The City of Galveston is situated on an island of sand formed by the combined action of streams, waves and ocean currents. The island is about 30 miles in length, narrow and but a little above sea level. It is this condition which made it possible for the tidal wave to do so much damage.

Almost immediately after the disaster the people began to rebuild the city and to lay plans for the future. An immense sea-wall of solid masonry several miles in length and many feet high has been completed. This, it is believed, will protect the city fully in case of any like occurrence in the future. In addition, the level of the city has been raised several feet.

On August 16, 1915, Galveston was again visited by a hurricane. The sea-wall afforded protection on the seaward side of the island, but flooding which did great damage to property took place on the landward side.

THUNDERSTORMS

As has been shown, cyclones and hurricanes are storms on a gigantic scale. The two classes of storms which remain to be considered, thunderstorms and tornadoes, are no less interesting although they are on a much smaller scale.

Thunderstorms are very local in area, and are of short duration. Like cyclones and hurricanes, they have a progressive movement, whirl, are areas of low pressure, and are accompanied by precipitation.

Place and Time.—While thunderstorms occur in all parts of the world, they are most common in the doldrum belt. There are both winter and summer thunderstorms, but they are most frequent during the hot spells of summer, and during the hottest hours of the day or the evening, because at these times convectional or upward currents are strong and warm moist air rises until the saturation point is reached.

Relation to Cyclones.—Many thunderstorms are but portions of some great cyclone. When this is the case, the storm, and often a series of them, is developed about 300 miles southeast of the storm center.

Still more local thunderstorms are known as heat thunderstorms. They occur after a number of hot days during which the ground, and the air immediately adjoining, are heated up to a high temperature. The air over the heated area rises, carrying with it much moisture. Such movements are known as *convectional* movements. Finally clouds and condensation occur. Thunder clouds are usually flat on the earthward side because condensation occurs at the same general level over all parts of the ascending air column. They are irregular on top because where the convectional currents are strongest the air is carried highest and the cloud masses are carried with it. The falling rain cools the air in the center of the column and causes it to descend. This colder, heavier air lifts that in the surrounding areas.

When two clouds are charged with electricity, the air between them is subject to a strain. The same is true as applied to a cloud and the earth. When the strain becomes too great, a discharge takes place. This is the lightning flash which lasts from 1/300 of a second to a second. The electricity is rapidly carried off by the rain; thus normal conditions are restored. Much of the electric energy is converted into heat owing to the resistance offered by the air.

TORNADOES

It is an interesting fact that the smallest of our storms are the most destructive. The tornado is very local and for its origin seems to depend upon (1) the presence of a cyclonic area, (2) rather high temperatures, and (3) great humidity. Although they are most frequent between April and July, these storms occur at all times of the year. Tornadoes are developed in the southeast quadrants of well marked lows. When warm, moist air rests upon the surface, lying beneath colder and heavier air, the conditions are favorable for storm development.

Appearance.—A tornado is, in reality, an overdeveloped thunderstorm. A great mass of whirling clouds appears, usually in the southwest. Sometimes clouds from the northwest collide with others from the southwest. Hanging from the tornadic cloud mass is a funnel-shaped cloud in which the air ascends and whirls with great rapidity. A terrifying roaring sound often accompanies the storm. The diameter of the funnel is usually less than 1,000 feet.

FIG. 23.—A tornado.

Size.—A tornado is seldom more than one mile in diameter and is often but a few hundred feet wide. Its progressive rate is from 20 to 40 miles an hour, but the rate of the whirl is often beyond the power of instruments to measure. These storms seldom last longer than one hour. In the narrow path pursued by one of these storms practically everything is destroyed.

Distribution.—Tornadoes are more frequent in the central portion of the United States than anywhere else. They are practically unknown west of the 100th meridian, because the humidity is too low.

The name tornado was applied to thunderstorms on the west coast of Africa more than 200 years ago.

Frequency.—There is no ground for the statement, sometimes made, that tornadoes are decreasing owing to the settlement of the country, nor for the opposite statement that they are on the increase. No obstacle which man can erect would break the force of these winds, as is well shown by the fact that the St. Louis tornado of May 27, 1896, encountered several miles of great brick buildings and left the city with more force than it had when it entered. On the other hand the facilities for spreading reports of storm havoc sometimes lead to the statement that they are becoming more numerous. They average in the United States about 45 per year, with about three particularly destructive ones. On February 19, 1884, there were 40 tornadoes in the Southern States between morning and midnight, and on March 23, 1913, there were five in eastern Nebraska and western Iowa.

Damage.—The property destroyed by these storms is great in value. As the tornado belt is constantly increasing in population, the amount of damage done is increasing. Between the Appalachian Mountains and the 100th meridian tornadoes destroy 1/14 as much property as do fires, while in New York State and in Pennsylvania the loss is but 1/140 as great as that resulting from fires.

The things which these terrible storms do are in many cases beyond belief. That the velocity of the whirl must approximate that of a rifle bullet is indicated by the fact that straws have been driven into trees by the wind. Chips have been forced through limbs four inches in diameter. Locomotives have been lifted from tracks; feathers stripped from fowls; water drawn from wells; houses caused to collapse, and many other equally wonderful things.

Pressure.—As a tornado approaches a place, the barometric pressure falls very rapidly. This fall may be so great as to make a difference of 300 pounds or more to a square foot. If a building is closed, the pressure cannot readily fall within the house, although it does without. There might then be an outward pressure of 300 pounds per square foot greater than the inward pressure. Such a condition would cause the walls of the buildings to fall outward. This result is frequently noted. Especially is this true of the upper story, which is more likely to be closed than the first floor.

St. Louis Tornado.—On May 27, 1896, the City of St. Louis was visited by a tornado of exceptional violence. Almost in an instant it destroyed about $12,000,000 worth of property and caused the loss of 250 lives. The pressure fell almost in a twinkling to 28.75. Here, as in the case of the Galveston hurricane, the people were warned beforehand. At ten o'clock of the day on which the storm occurred a telegram was sent from the central office, warning all cities in the central portion of the Mississippi Valley. Following this, the Chicago and the St. Louis offices issued warnings.

Immediately upon the issuance of the warning, the school children in St. Louis were dismissed. The whirl in this storm was at the rate of 120 miles per hour. It is believed that in some storms it has equaled 500 miles per hour. The whirl is most violent on the right hand side.

Theories.—There has been a number of suggestions made looking toward the prevention of loss of life and property through the action of these storms. One theory holds that they are electrical storms and that their destructiveness can be avoided by planting trees to the southwest of the towns in the tornado belts. This suggestion is based on the fact that little damage has been reported from sections lying northeast of timber. While there is electricity in these storms, it is not generally believed that it is the electricity which gives them their chief power. The suggestion has also been made that stations armed with powerful dynamite guns be established, and that as a tornado passes within range of one of these stations it be fired into in hope of breaking up the whirl.

It seems pretty well established that the damage is the result of the force of the wind and the difference between barometric pressure within and without buildings. Probably the most powerful weapon which can be used in fighting this monster is the knowledge spread by the Weather Bureau. While the exact spots to be visited by a tornado cannot always be foretold, yet the districts in which they may be expected can be warned twelve to twenty-four hours in advance, thus enabling people to be on the watch for the approach of the storm, and to seek places of safety.

STUDIES

Why do cyclonic areas whirl anti-clockwise in the northern hemisphere? Why is the east side of a temperate latitude cyclone most subject to precipitation? Discuss the benefits derived from temperate latitude cyclones. Explain the absence of hurricanes from the South Atlantic Ocean. What causes the so-called tidal wave? Why do so few hurricanes enter the Gulf of Mexico? At what time of the year are thunderstorms most frequent in your locality? Explain. Explain the distribution of tornadoes in the United States.

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CHAPTER VI

THE MOISTURE OF THE ATMOSPHERE

General Statement.—Next after temperature, moisture is the most vital factor in our atmospheric environment. In the same general latitude we find the tropical forests of Central America, with their richness of lower forms of life, and the burning wastes of the great Sahara; the populous agricultural section of the Middle West and the sparsely populated dry plains west of the one hundredth meridian. It is evident that the amount of moisture in the atmosphere, and its distribution, are closely related to man's activities and welfare.

The atmosphere is a sort of "middle man," the great distributor of moisture, by means of which water gets from the ocean to the fields and forests, the springs and wells. If the atmosphere did not perform the function of receiving this gift from the ocean, and tendering it to the land, the earth would soon become a barren waste.

Capacity of the Atmosphere for Moisture.—We speak of the capacity of the atmosphere for moisture as we might speak of the capacity of a box or a pail. As a given volume of air is expanded by increase of temperature, and contracted by decrease, it follows that the capacity of the atmosphere for moisture varies accordingly. A room 20′ x 20′ x 20′, at a temperature of 68° F. and air saturated, contains about 3.8 pints of water in the form of vapor.

Absolute Humidity.—The amount of moisture which the atmosphere actually contains at a given time is spoken of as the absolute humidity of the air. This is frequently expressed in grains per cubic foot. At 32° F. the maximum amount of water vapor which a cubic foot of air can contain is 2.11 grains. The maximum at 90° F. is 14.79 grains. Most of the water vapor is close to sea level and 9/10 of it is below the altitude of 21,000 feet.

Relative Humidity.—The amount of moisture in the atmosphere, compared with what it could contain at the same temperature and pressure, is spoken of as the relative humidity. With change in temperature there is change in capacity, and therefore change in relative humidity. For example, the air in a room might be quite humid at a temperature of 70°, but quite dry at a temperature of 90°.

Proof that the Atmosphere Contains Moisture.—Place a basin of water in a place where it cannot be disturbed, and in a short time the water disappears. It has passed into the atmosphere. Place a stopper in an empty bottle and warm the bottle. Now plunge it into a basin of cold water. Drops of moisture collect on the inside of the bottle. These simple experiments prove that the atmosphere contains moisture.

Variation in Humidity.—The relative humidity over the oceans is always high. In the neighborhood of the equator it averages 82 per cent., while in higher latitudes it is commonly 90 per cent. or more. On the summit of Ben Nevis, Scotland, the mean annual relative humidity is 94 per cent.; on Pike's Peak, 78 per cent. In some portions of the arid southwest it is not more than 15 or 20 per cent.

Evaporation.—The process by which liquids or solids are converted into vapor is evaporation. The molecules of water are believed to be in constant motion. Occasionally some, on account of very rapid motion, pass from the water body to the air. The number of molecules passing into the air—that is, the rate of evaporation—depends upon the temperature and the humidity of the air. In the process of evaporation heat is lost, and this is known as the *latent heat of vaporization.*

Evaporation is very rapid in an arid region. It amounts, on some of our desert areas, to 150 inches per year. This does not mean, of course, that 150 inches of water are actually evaporated, but it is a statement of the possibilities of evaporation. In the tropics about 90 inches are evaporated from the ocean per year. At the latitude of about 40° about 30 inches, and in polar regions only about 10 inches are evaporated annually.

Condensation.—When the movement or velocity of the molecules of water equals the velocity of those of the vapor, the process of evaporation ceases and condensation occurs. In other words, a fall in temperature diminishes the capacity of the atmosphere for water vapor, increases the relative humidity, and saturation occurs. The dew point is the temperature at which the invisible particles of moisture collect and become visible.

FORMS OF PRECIPITATION

Dew.—Perhaps the most common form of precipitation is dew, for it occurs in most regions every night. The earth rapidly radiates its heat at night, and this cools the atmosphere resting on it. Its relative humidity steadily increases until the saturation point is reached. As the blades of grass and leaves of trees and plants cool more rapidly than the air, much dew collects on vegetation.

There is much variation in the amount of dew that collects on areas not far apart. Dew may be abundant in the bottom of a ditch and much less abundant on the bank. This is because the air in the ditch is more humid, and also more quiet. A cloudy night is unfavorable to the formation of dew because the clouds check radiation, hence the fall in temperature is slow.

While dew is of some value to vegetation, its value is frequently overestimated. In Central Europe the amount of dew in a year amounts to about one inch, or three per cent. of the total yearly rainfall. Dew often protects vegetation from freezing, for the drops of water hinder a further loss of heat through radiation.

That dew does not *fall* can be shown by inverting a bowl on a box or a cement walk at night. Moisture will be found on the inside of the bowl in the morning. Most dew is moisture taken directly from the air through cooling, but some dew is formed through the transpiration of plants. A great deal of moisture is being returned to the air in this way.

Fog is another common form of precipitation. It forms along the surface of the earth, particularly in low damp places, because the air reaches the saturation point. The very presence of the fog tends to hinder its increase near the surface, but as its upper surface loses its heat the air resting upon it is chilled, and so the fog layer grows upward.

While fog is, to a certain extent, a benefit to vegetation, it is in some sections a menace to life. Off the Newfoundland Banks fogs are very frequent and dense. There are about 165 foggy days per year in that region, and as a result many ships and human lives are lost yearly. These dense fogs are, in part at least, due to the melting of icebergs in this vicinity. In Southern California bean growers often suffer a serious loss if a number of foggy days occur immediately after the crop has been planted, as the seeds then rot in the ground.

As each particle of dust in the atmosphere serves as a center for condensation, fogs are often frequent in the vicinity of large cities. This is notably true in London, where they cause great expense for increased lighting and fuel. "It has been estimated that the cost of gas burned during one day of an ordinary London fog approximates $15,000."[1]

Clouds are particles of moisture, sometimes water and sometimes snow and ice, that have collected and become visible. They are commonly formed by air masses ascending, cooling and expanding as they rise. They are also formed when air masses come in contact with a cold mountain top, and by the mixture of air at different

[1] Ward, R. DeC.: "Climate," p. 320.

temperatures. It is found by actual experiment that there is more dust in clouds than in unclouded air at the same altitude. Hence it seems clear that clouds are often formed as a result of ascending air taking up dust with it. The particles of water in a cloud vary from 1/4000 to 1/1000 of an inch in diameter.

Kinds of Clouds.—The four important classes of clouds are: *cirrus*, or lofty fleecy clouds; *stratus*, or those arranged in layers; *cumulus*, or the banked masses; and *nimbus*, or rain clouds. Clouds vary in height from a few hundred feet to several miles. They are

Courtesy W. G. Scott.

FIG. 24.—Cumulus clouds.

most abundant between the altitudes of one-half mile and one mile. As clouds furnish the earth with its precipitation, as they influence the distribution of insolation, and as they are aids in the forecasting of the weather, their importance is evident.

Frost occurs at temperatures lower than 32° F. The results of frost are seen on lowlands before they are apparent on adjacent higher ground. Air at moderate elevations, being relatively dry, cools more rapidly than that at lower levels. This colder heavier air drains to lower levels, increasing the probability of frost there.

The nature of the cooling substance has much to do with the formation of frost. For example, the rails of a track and the ties are often coated with frost when none can be seen on the ground in the immediate vicinity. In the bottom of a ditch two feet in depth one can frequently find frost when none can be seen on the banks. Windy and cloudy nights are not favorable to the formation of frost.

The Weather Bureau is of great assistance to farmers and fruit growers, for it warns them of approaching frost. Special bulletins, telegrams and telephone messages are issued in order to give the greatest number of persons warning. The cranberry, corn and orange growers are among those who reap the greatest benefits. Some orchardists build fires on the windward sides of their orchards so that the smoke may drift over them and thus check radiation. In California it is common to place under the trees in the grove heaters in which crude oil is burned. Frosts in Florida are much more destructive than in California because of the fact that there is nothing to obstruct the movement of a cold wave when it starts toward the Gulf. Cranberry growers protect their crops by flooding the land. Cultivation, drainage and placing a layer of sand upon the soil also check frost.

Frequently the greatest damage results from the increase in temperature following the frost. The rise in temperature after sunrise may be more rapid than the fall in temperature of the night before. The resulting expansion of the tissues or the fruit of the plant is injurious. Spraying the plant with cold water checks the increase in temperature. A cloud of smoke has the same effect.

Snow.—Snow occurs when the condensation point is below 32° F. but not low enough to produce pellets of ice. As the capacity of the atmosphere for moisture rapidly decreases with decrease in temperature, snowfall is not so heavy in regions of exceedingly low temperature as in those of somewhat more moderate temperature.

At different points along the same vertical section of a storm it may be both raining and snowing. Within a few hours it is possible to pass from a rainstorm in the valley to a heavy snowstorm on the mountains.

Snow is directly related to human affairs in many ways. Years ago a great snowstorm often completely blockaded trains, hindering their movement for days. Powerful rotary snow plows now offer a very effective means of keeping tracks reasonably free from snow, yet there is often much delay. When the snowfall is unusually heavy and long continued, it costs such cities as New York and Chicago thousands of dollars to remove it from their streets so that traffic can be carried on.

The cattle men on the Great Plains suffer heavy loss when the ground is covered with snow for a number of days, for ordinarily the cattle secure their living out of doors even during the winter. The lack of heavy snowfall on these plains is due to their dryness, and to the dry and relatively warm Chinook winds which come down the eastern slope of the Rocky Mountains. On the western side of the mountains these winds are moist, and there most of their moisture

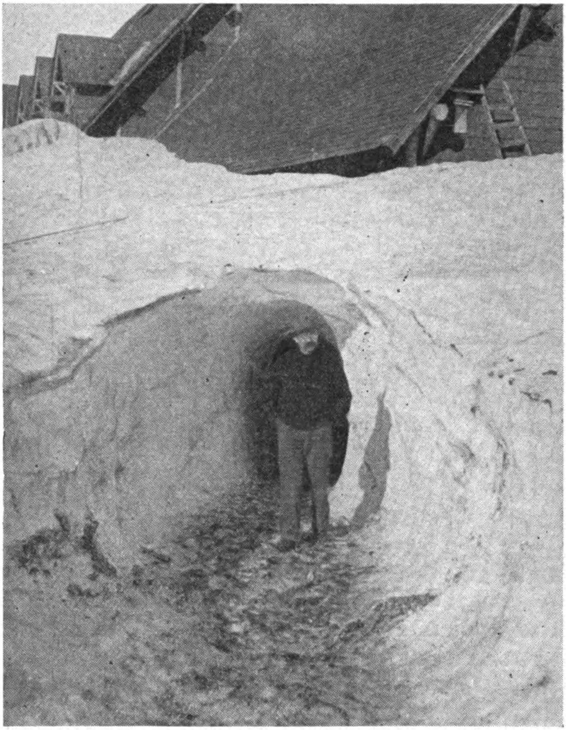

Photo by Chamberlain.

FIG. 25.—Relation of snow to man, Paradise Valley.

is precipitated. As a result of precipitation much heat is set free, hence the winds as they pass over the mountains do not reach as low a temperature as they otherwise would. The descending wind is remarkably dry. It is also warm because of the compression due to the descent. Under the influence of this wind snow rapidly disappears. The Chinook is, therefore, a wind having great economic value.

Snow is of great value in preventing plants from winter-killing.

Wheat sown in the fall is not likely to produce a good crop if the ground is bare much of the time during the winter. Trees and other forms of plant life are more likely to be destroyed by frost when there is little snow, for the frost can then penetrate to great depths.

Snow being a poor conductor, heat is slowly radiated from the earth to the air when snow covers the ground. Animals and human beings have often escaped death from freezing by crawling under a bank of snow. "The Scotch black-faced sheep, valued for its sweet mutton rather than for its coarse carpet-making wool, are found alive but emaciated after three, four and five weeks' burial in a snow-drift. When the shepherd is at length able to dig them out, he finds that they have subsisted upon their own breast-wool and such portions of heather and heather-root as could be reached without moving more than their heads."[2]

In arid regions the snow which falls on the mountains is of great benefit. Every foot of snow there collected means, on the average, an inch or more of water for an equal surface in the valley below. If snow is compact, a foot will make more than one inch of water.

The amount of snow on the ground has much to do with the temperature of the air. Until all of the snow has melted the ground cannot gain a temperature higher than 32° F. Hence late springs result when there is much snow on the ground.

Hail is frozen raindrops. Hailstorms occur chiefly during our warmest weather. At such times, owing to the intense heating of the ground and consequently of the air adjacent, ascending currents rise to a great altitude. When condensation occurs, the drops of water cannot overcome the upward movement and so are carried to greater altitudes. Here the drops freeze and finally fall. An ascending current of unusual force takes the pellets of ice up once more. Here the moisture on the outside freezes, forming a second coating or layer of ice. This may be repeated a number of times until the hailstones become too heavy to be carried up again.

If one breaks open a number of hailstones some of them usually show this banded structure. Hailstones are frequently of such size as to do great damage, especially to growing crops; and cattle have been killed by them.

A hailstorm of great violence occurred in southwestern Nebraska on August 8, 1917. Much damage was done to crops, poultry, pigs, cattle and horses. The storm track was about 92 miles in length and

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[2] Hunter, J. A.: "Wool," p. 7.

from 4 to 12 miles in width. A photograph was taken showing the hailstones and also some apples which had been knocked from the trees by the storm. So nearly of the same size were the apples and the hailstones that in a photograph it is not easy to distinguish between them.[3]

In France and Italy there are many stations equipped with guns which bombard hailstorms when they approach the vineyards. The point seems to be to break up the ascending currents, thus changing the hailstorm into a rainstorm. It is not generally believed by scientists that this method is of value in preventing the storms.

Rainfall.—Rain is the form of precipitation in which man is most interested. The distribution of forests, the success of agriculture, the nature of the crops, the density of population, the construction of railroads, and, in short, the prosperity of the human race generally, depend in no small measure upon the amount and the distribution of rainfall. "In Kansas and Nebraska, in 1900, the value of one rain, lasting twenty-four hours, in saving the corn crop was put at over $80,000,000."[4] No sharp line can be drawn between mist and rain. Raindrops vary from .03 to .2 inch in diameter.

In general, a region in which the annual precipitation averages less than twenty inches will be one in which agriculture, if carried on at all, will depend upon irrigation. Much, however, depends upon the distribution of the rain and the nature of the soil. Over large areas in California and other western states the average rainfall is less than 10 inches, and yet profitable crops of wheat are grown without irrigation, because the rain falls during the growing period, and the crop has nearly matured when the dry season begins.

The one hundredth meridian, in a general way, forms the dividing line between that portion of our country in which the annual precipitation is more than twenty inches and that in which it is less. To the east of the line agriculture flourishes; west of it, stock raising and mining are the leading industries.

The study of a rainfall chart of the world is interesting and profitable. It shows how great is the range in the amount of precipitation at different points. (1) We see that in general the rainfall decreases from the equatorial to the polar regions, although there are marked exceptions to this. (2) Rainfall decreases from the coast toward the interior. (3) In the tropical zone the greatest rainfall is on east

[3] Loveland, George A.: *Monthly Weather Rev.*, 45, 540.

[4] Ward, R. DeC.: "Climate," p. 319.

coasts and eastern slopes of mountains, while in the temperate zones western coasts and slopes are favored. (4) The windward sides of mountains receive more rainfall than do the leeward sides. (5) Precipitation increases up to a certain altitude and then decreases. In the temperate zone this varies from 6000 to 7000 feet. (6) In the doldrums rainfall is abundant on both sides of the mountain ranges. (7) The hot deserts lie within and adjacent to the tropical zone.

The following illustrations of the distribution of rainfall are instructive: On the west coast of the Scandinavian Peninsula the maximum mean annual precipitation is more than 100 inches. On the opposite coast it is from 50 to 60 inches. Localities on the west coast of Scotland receive more than 200 inches of rain per year, while on the east coast the maximum varies from 60 to 80 inches. On the northeastern coast of the island of Hilo (Hawaiian Islands), the maximum annual rainfall is 350 inches. On the west coast the maximum is less than half of this.

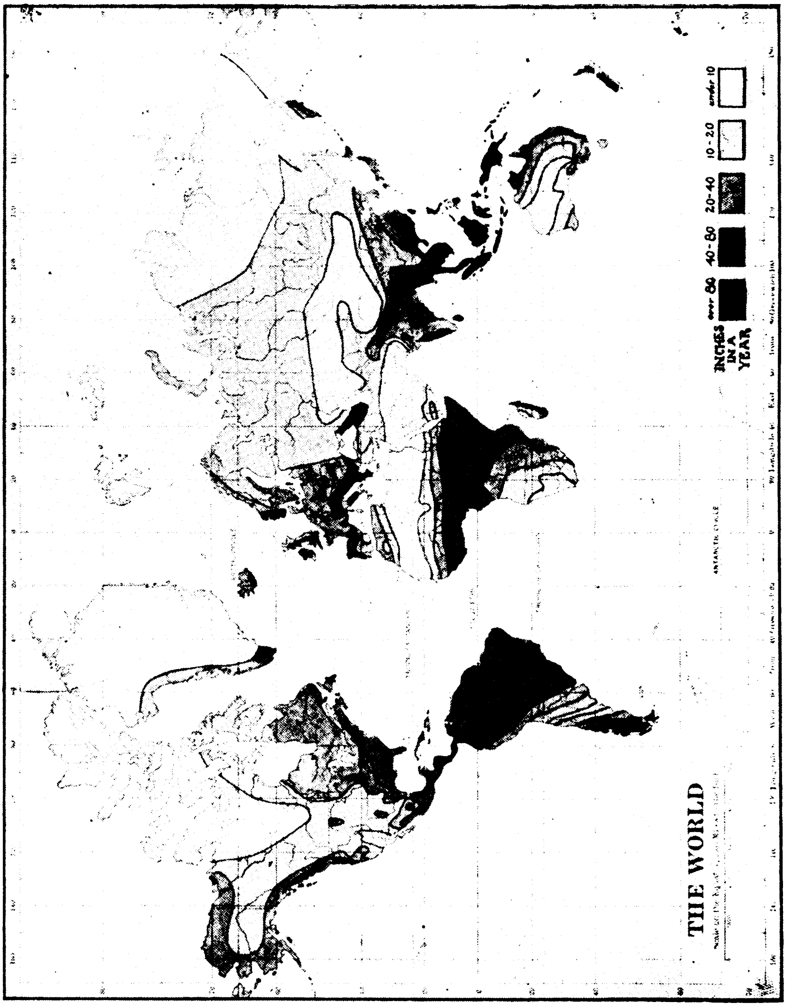
The heaviest recorded rainfall occurs in India. Here, northeast of the Ganges basin, 600 inches, or 50 feet, have been recorded in a year, while the average precipitation is 474 inches. Over 400 inches of the total fall between May and September. On the plateau of the Deccan the precipitation is so slight that people have irrigated the land for ages.

The great rainfall in India is due to the southwest monsoon. The winds, laden with moisture, are compelled to ascend the lofty Himalayas, and in ascending are cooled to such an extent that most of their moisture is lost on the south side. On June 14, 1876, forty inches of rain fell in twenty-four hours, or an amount as great as the average annual precipitation in New York City.

A rainfall of 29.5 inches in twenty-four hours is recorded in Japan. In New London, Connecticut, 11.8 inches of rain fell during a period of twenty-four hours. At Juana Diaz, on the Island of Porto Rico, 11.20 inches of rain fell between 6 A.M. August 8, 1899, and 6 A.M. of the following day.

For reasons that are apparent, no very definite information can be had as to the precipitation on the ocean. The following is an approximation to the truth as applied to rainfall on land:

6 per cent. of the surface receives over 75 inches yearly.
16 per cent. of the surface receives over 50–75 inches yearly.
25 per cent. of the surface receives over 25–50 inches yearly.
30 per cent. of the surface receives over 10–25 inches yearly.
20 per cent. of the surface receives less than 10 inches yearly.


THE WORLD
INCHES IN A YEAR
over 80
40-80
20-40
10-20
under 10

Rainfall in North America.—The northwestern and the southern coasts of North America are most abundantly watered. The first mentioned area receives its rain from the westerlies. There is a marked increase in the rainfall as one travels from south to north. At San Diego, California, the normal annual precipitation is 10 inches; at Los Angeles, 15 inches; at San Francisco, 25 inches; along the Washington coast, about 100 inches; at Sitka, 111 inches. This increase is due to the fact that with increase in latitude there is a decrease in mean annual temperature and an increase in the length of the wet season. The region east of the Rocky Mountains gets much of its moisture from the Gulf of Mexico.

Fluctuations in Rainfall.—The statement is often made that the rainfall is increasing or diminishing. The only basis for such statements is the result of observations extending over a long period of time. Such records indicate that there are 35-year periods of fluctuation in rainfall, but do not, as a rule, show any continuous increase or decrease in precipitation.

The intensity of the range increases toward the center of the continents. In Central Siberia the precipitation during the wet period is 2.3 times as great as during the dry. In England it is 1.2 times as great. During the wet period the isohyet (line connecting places of equal annual precipitation) of 24 inches extends 1,000 miles farther inland in Asia, and 700 miles farther in North America than it does during the dry period.

Rainfall and Forests.—There has been much discussion as to the relation between rainfall and forests. Many have maintained that forests increase the precipitation. The consequence has been mistaken for the cause. Abundant precipitation increases plant growth, but there is little evidence that forests induce rain. Theoretically, since the leaves of the trees cool more readily than does the atmosphere, forests should increase precipitation. The records in some parts of the world indicate that this is the case, but the records in other areas do not.

Production of Rain by Artificial Means.—The question of producing rain by artificial means is one of great interest in arid regions, and has called forth much comment. One should not credit or discredit statements concerning the matter without having some definite knowledge along this line.

A number of years ago extensive operations were carried on in Texas and other sections of the Southwest. The sky was bombarded repeatedly, and on a very few occasions a few drops of rain fell. So feeble were the results that scientists are not able to tell whether they were the result of the bombardment or of natural consequences.

In Southern California much attention has been given to efforts to produce rain by artificial means. Since in most cases rain has followed these efforts, they have by many people been declared successful. A careful study of the weather records shows that the conditions were not local, and leaves the impression that the experiments were in no sense responsible for the precipitation.

It is earnestly to be hoped that science may discover how to wring from the atmosphere the priceless boon that it holds in its possession, but in all probability we shall be compelled for some time to come to accept the results of the operation of natural laws.

STUDIES

Compare the rate of evaporation on the Sahara and in the British Isles. Account for the difference. Shipwrecks are frequent in the vicinity of the Grand Banks. Why? Why does a cloudy night tend to prevent frost? At what season are hailstorms most common? When rain is actually falling the hygrometer may show that the relative humidity is less than 100 per cent. Explain. Explain and apply each of the generalizations as to the distribution of rainfall. On cross-section paper make a graph showing the average annual and the yearly precipitation in your vicinity. What does a study of the graph bring out as to fluctuations in rainfall?

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CHAPTER VII

The Weather and the Weather Bureau

General Statement.—No matter where we may live or what our occupation may be, our daily lives are influenced in a multitude of ways by the weather. A rain may cause the postponement of an excursion; it drenches the clothing of thousands of persons who are exposed to the weather; it stops work on the farms and on the construction of buildings; it damages hay and grain; it benefits growing crops; it is an opportunity for many country boys to go a-fishing. When it is very hot, people are lacking in energy, and real work, whether physical or mental, is carried on with difficulty. A cold wave puts vigor into people and serves as an excellent tonic.

An unseasonable frost or a drought may injure the corn crop to the extent of hundreds of thousands of dollars. A blizzard may work havoc on the cattle ranches in northwestern United States and southwestern Canada, and temporarily tie up traffic on the railroads. The melting of snow due to the passing of a warm wave may cause a disastrous flood on the Mississippi or the Ohio. A tornado may cause the loss of millions of dollars worth of property in a single city. A storm or a fog at sea may result in the loss of several ships. "The state of the weather sometimes fixes the load of an engine, as in the case of freight trains running west from Pittsburgh, Pennsylvania. According to the weather forecast of favorable, reasonably good, bad, and very bad weather, the load of a freight engine varies from 1750 tons to 1225 tons."[1] These are some of the many ways in which weather influences our daily lives.

Because of the vital relationship between weather conditions and human beings, man has for ages observed the sky and the winds closely in order to guard, in such a manner as he might, his flocks, herds and crops. Such knowledge and supposed knowledge as he has in this way acquired has been handed down from generation to generation in the form of terse sayings or weather proverbs.

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[1] Ward: "Climate," p. 315.

By weather is meant the atmospheric conditions that prevail at some particular period of short duration. Thus, we speak of the weather today, or as it was last week or last month. When our statements apply to a long period of time, as a year or a number of years, we use the term climate.

In a given place there is a regular diurnal variation in weather conditions due to the rotation of the earth and a seasonal variation due to revolution. These being regular, are anticipated and we govern ourselves accordingly. The weather changes which most vitally affect us are those which, while frequent, do not occur at regular intervals and whose intensity can be known beforehand approximately only. To make known as far in advance as possible the time and the character of these weather changes is an important work of the Weather Bureau.

When it became known that storms have a progressive movement, that they follow the same general course and at an average rate of speed, it was evident that weather conditions could be foretold. A prediction or forecast could be of no value, however, unless it could be transmitted at a rate greater than that at which the storms themselves travel. It was not until after the invention of the telegraph, therefore, that a weather service could develop. The beginnings of the service in our country were laid by the work of Franklin, Espy and Redfield.

In 1870 the United States Government organized the work. Ours was the fourth nation to take such a step, France, Holland and Great Britain having preceded us in this important matter. Our service is a branch of the Department of Agriculture. In 1870 Congress appropriated $20,000 for carrying on the work. For the year ending June 30, 1916, the appropriation amounted to $1,666,050. This is a larger sum than is spent for the same purpose by all of the countries of Europe combined.

Making and Distributing the Map.—Each morning and evening, at 8 o'clock (Washington time), trained observers in some 200 Weather Bureau stations in all sections of the United States carefully observe and record the conditions of the weather. From each of these stations the reports are telegraphed to each station where a map is issued. About an hour after receiving the reports, a map showing the existing conditions, and giving a forecast for the 36 hours immediately following, is ready to be mailed to interested persons. At the Washington office two maps are issued daily, but at other stations but one. These maps are sent to post offices, libraries, schools, commercial bodies, farmers, fruit growers and others. In addition, the map is now published in a large number of daily papers. The commercial map is prepared at about 100 stations, and through the Postal Service is very widely distributed.

The forecast printed on a card is mailed to a very large number of farmers and other interested persons, and is published in about 2000 daily papers. In addition, cars are often placarded so that as the trains rush through the farming districts the farmers may read the forecast. A system of locomotive whistles is sometimes employed, and information is constantly being distributed by means of telegraph and telephone. From a few places in the United States forecasts are now distributed by wireless.

People upon the water as well as those upon the land are furnished this information concerning the weather. At every important sea and lake port in our country there are towers in which storm warnings are displayed. The signals are flags by day and lights by night. A square red flag with a black center indicates the approach of a severe storm, and few captains will put to sea when they observe this warning. As thousands of ships of all sizes leave our Atlantic and Gulf ports yearly, the importance of this service can be realized. In 1916 storm signals were displayed at 363 different points along our sea coast and on the Great Lakes.

"Forty years ago mariners depended on their own weather lore to warn them of coming storms; then, although the number of ships plying the oceans was much less than it is now, every severe storm that reached navigable waters left death and destruction in its wake, and for days afterwards the dead were cast up by the subsiding seas and the shores were lined with wreckage that represented a loss of many millions of dollars. Happily this is not now the case; the great mass of shipping takes warning and rides safely at anchor in convenient harbors."[2] "Formerly 75 per cent. of the loss in shipping on the Great Lakes was wrought by storms, whereas now, owing to the efficiency of the storm warnings, less than 25 per cent. of our annual loss can be attributed to the work of storms."[3]

Many people today doubt the accuracy of the Weather Bureau forecasts. An excellent way to test the matter is to copy a con-

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Moore: "Descriptive Meteorology," p. 224.

[3] Grosvenor, Gilbert H.: *National Geographic Magazine*, vol. xviii, p. 590.

siderable number of forecasts, say 100, and make opposite each a record of the weather as it actually existed on the day to which each forecast refers. The following statements are very instructive. "The annual percentage of verification for the 12 months ending June 30, 1912, was 88.5, or 7 per cent. higher than in 1893."[4] "The verifications of all forecasts during the year 1914 averaged 88.4 per cent."[5]

Benefits Derived.—From the standpoint of value of crops in the United States hay ranks second. Both hay and grain are often greatly damaged by rains during the harvesting season. When farmers know 36 hours in advance of the approach of a rainstorm they will not cut grass or grain and will use every effort to place under shelter cured hay and grain. This results in a great saving.

When a severe blizzard is predicted, stockmen round up their cattle and prepare to feed them. Railroad officials put snow plows in readiness, and telegraph and telephone companies have their forces ready to quickly repair disabled lines.

Among the very valuable warnings are those pertaining to frost. The approach of a cold wave is of special importance to fruit and cranberry growers and truckers. In addition to the regular service special frost warnings are sent to several districts in each of the following states: North Carolina, Florida, Louisiana, Texas, Colorado, Utah, California, Oregon, Washington, Idaho, Wisconsin, Ohio, New Jersey and Massachusetts.

When a frost warning reaches the growers of citrus fruit in California, they at once prepare to protect the trees by the use of heaters. During December, 1912, a very severe frost occurred in California which damaged oranges and lemons very greatly, the loss being placed at $6,000,000. Had the growers not received timely warning the loss would probably have been several times as great.

When frost threatens the cranberry crop, the growers flood the marshes. As water is a poor conductor, the berries are protected. Of course the water must be drawn off within a day or two, or it would injure the crop.

A large river in flood is an uncontrollable giant. Its power is almost irresistible. It uproots trees, tears away the banks, washes out bridges and sweeps along houses. Between the mouth of the Ohio

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[4] *Yearbook U. S. Dept. of Agriculture*, 1912, p. 178.

[5] P. C. Day: Chief Climatological Division, Weather Bureau.

and the mouth of the Mississippi there are thousands of square miles of land but slightly above the ordinary level of the Mississippi. The cities along the river, as well as country districts, suffer great loss on account of floods. As floods are caused by weather conditions it is quite natural that the Weather Bureau should make a study of floods.

Records of the precipitation are taken at many points in a river basin, and the results of the precipitation upon the river level noted. The depth of the snow and the results of thaws are recorded. The length of time that it takes high water under varying conditions to travel from one point to another is ascertained. Such investigations as these have made it possible to forecast river floods with remarkable accuracy. Forecasts are now made for periods varying from one day to several weeks.

"During the Mississippi floods of 1897, property to the value of about $15,000,000 was saved through the Weather Bureau flood warnings, and as much during the flood of 1903, while during the great flood of 1912, a saving exceeding $16,000,000 was reported. During a single flood in the Sacramento Valley of California in 1909 property to the value of $300,000 was saved through the warnings of the Weather Bureau, and similar instances are matters of frequent record."[6] The floods along the Mississippi in 1912 were the greatest in the history of the country. The forecast for the highest stage at New Orleans was issued nearly five weeks in advance, yet it was absolutely accurate.

The flood warnings enable people living in areas subject to inundation to move their families, goods of various kinds, and live stock. Also it gives much opportunity to strengthen levees at weak points. The time and the height of the crest at New Orleans in the flood of 1903 was announced 28 days in advance.

"From the data that now covers many years at a large number of stations the following general rules have been deduced: The time it takes high water to pass from Pittsburgh to Wheeling is one day; from Pittsburgh to Parkersburg, two days; from Parkersburg to Cincinnati, three days; from Cincinnati to Cairo, six days; from Cairo to Vicksburg, seven days, and from Vicksburg to New Orleans, four days. The time, therefore, from Pittsburgh to the Gulf is twenty-one days."[7]

The snow that falls upon the mountains adds to the water supply

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[6] *Yearbook of the Department of Agriculture*, 1912, p. 183.

[7] Moore: "Descriptive Meteorology," p. 240.

of the valley below. This is of importance to those who irrigate, to those who are using power developed from the streams, and to those interested in navigation. The Weather Bureau keeps careful records of snowfall. From these records the amount of water available at various points during the following summer is worked out. If the amount is to be above the average, water companies can make contracts for the season for larger quantities, and consequently a larger area can be cultivated.

Reasons for Failure of Forecasts.—That the predictions made by the Weather Bureau are not always fulfilled is a matter of common knowledge. There are a number of reasons for this. (1) The ordinary storm tracks are not always followed. (2) A given storm may travel much more slowly or much more rapidly than the average. (3) Occasionally a storm dies out unexpectedly, or a new storm develops under conditions that do not warrant the forecasting of a storm. (4) Sometimes, owing to the destruction of telegraphic communication, there is not sufficient data upon which to base a forecast. In spite of the many failures the work is remarkably accurate. It has been estimated that the United States saves $30,000,000 per year as a result of the work of its Weather Bureau.

Studies are constantly being made with a view to making the work yet more valuable. It is believed by some that the sun spots exert a marked control over weather conditions; accordingly, the sun is being carefully studied from this point of view. That a more complete knowledge of the upper atmosphere would help wonderfully in solving the problems is generally conceded. For years kites and balloons having meteorological instruments attached to them have been sent up, and much knowledge has thus been acquired.

It is reported by P. C. Day, Chief of the Climatological Division of the Weather Bureau, that the greatest altitude ever reached by a sounding balloon in the United States is 32.6 kilometers, or a little more than 20 miles. "The ascension was started at Santa Catalina Island, off the coast of Southern California. The pressure at the highest point recorded 7.4 millimeters, and the temperature —41.8 C."

STUDIES

Keep a record of the weather forecast for one week, and state the number of days on which it was fulfilled. Why are the forecasts more accurate now than they were 25 years ago? Would you expect the same degree of accuracy in San Francisco and New York? Explain. Write a paper giving illustrations of the influence of the weather upon human affairs in your vicinity.

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CHAPTER VIII

Climate and Its Relations to Life

General Statement.—Situated between the mountains and the sea, in southeastern France and northwestern Italy, is a narrow strip of land known as the Riviera. Although as far north as Chicago, the Riviera has a delightful winter climate. When snow and ice prevail in our North Central States the Riviera is bathed in warm sunshine. In fact frost seldom occurs in this favored land and flowers bloom out of doors in the winter.

Because of the mild climate orange, lemon and olive trees are grown, and citrus fruits, olives and olive oil are exported. Large quantities of cut flowers are shipped to areas less favored climatically and vast quantities of blossoms are used in the manufacture of perfumery.

Naturally, the climate of the Riviera attracts many people from other parts of Europe and even from the United States. As a result, the winter population is much larger than the summer population. Millions of dollars have been expended in the construction of excellent roads and in the erection of splendid hotels. The entertainment of tourists is one of the most important lines of work.

Among the tourist resorts of the French Riviera are Cannes, Nice, Grasse, Monaco, and Mentone. In Italy are Ventemiglia, St. Remo, Porto Maurino, Oneglia and others. Palatial homes, usually of brick or stone, nestle among semitropical trees and flowers of many kinds. The area is one of light rainfall, but man's response to favorable temperature conditions has resulted in the very high development of the region.

This illustration makes it clear that climate exerts a powerful control over the lives of men. It is, indeed, the most important factor in our geographic environment. This being true, it is evident that we should know the climatic conditions that exist in all parts of the world, the causes underlying these conditions, and the results of climate.

Dr. Ellsworth Huntington has made an exhaustive study of the influences of climate upon human life. His study indicates that neither very high nor very low temperatures are favorable to the best physical or mental effort, and that uniformity in temperature conditions are about as deadening as extreme temperatures. Frequent storms seem to furnish favorable conditions, while very high and very low relative humidity discourage effort.

Temperature is the chief element in climate as it is in weather. Temperature depends primarily upon the angle at which the sun's rays strike the earth. As the earth's axis is inclined 23½° from a perpendicular to the plane of its orbit, the vertical rays of the sun never fall north or south of the tropics (latitude 23½° north and south of the equator).

Tropical Zone Climate.—The tropical zone is then, as the name indicates, the warmest belt on the earth. Speaking of the lower levels we may say that the temperature is always high and subject to slight seasonal changes. As day and night are always nearly equal in duration (day in the tropical zone is never less than about 10½ hours in duration and never more than about 13½ hours), the diurnal ranges are less than they would otherwise be.

In a large part of the tropical zone the mean annual range in temperature is less than 10° F. At Equatorville, on the Congo, it is only a little more than 2° F. At Iquitos, Peru, it is less than 5° F. The mean annual range in the temperature of the surface water of the ocean along the equator is about 4° F. The Challenger Expedition showed that the mean daily range in surface water at the equator is only 0.7° F. and that the diurnal range in the air over the ocean in the tropical zone averages from 2° to 3° F.

The prevailing wind is the trade. Where this blows from the sea to the land and encounters lofty mountains, the rainfall is heavy and great forests result, as in large parts of equatorial Africa and South America. Where the trade blows from the land to the land, or does not encounter high mountains, desert conditions prevail, as in the Sahara. In the doldrums, as we have seen, the air is constantly rising and reaching the condensation point. In this belt heavy rainfall occurs on both slopes of north to south mountains.

The constant high temperatures and the great humidity which exist in many areas are very detrimental to the development of man. No great nation has ever developed within the humid lands of the torrid zone. There is no non-productive season for which provision must be made. Nature is so lavish that there is little incentive to or need for labor. Food in abundance is easily secured, and little is required by way of clothing and shelter.

Frigid Zone Climate.—In the frigid zones the sun's rays strike the earth at a low angle, and hence comparatively little heating results.

Temperatures, even in the summer, are always low. At the poles day and night are synonymous with the season, each being six months in duration. Hence there are marked seasonal changes in temperature. In all parts of the frigid zone there is a greater variation in the length of day and night than in any other part of the earth.

Owing to the long period of sunshine during the summer, insolation in polar regions is very great. "At the time of the summer solstice, the area immediately about the North Pole receives 20% more heat than an equal area at the equator ever receives, and 36% more than the equatorial region receives at the same time."[1] As the temperature cannot be raised until the snow and ice are melted, the climate remains cold even during the summer.

There is comparatively little land in the frigid zone, and this tends to reduce the seasonal variations in temperature as compared with what they would otherwise be. In the frigid zone Nature imposes such severe conditions of life upon her children that living is reduced to mere existence.

In the northern part of both North America and Eurasia are areas where the summer temperature rises above 32° F. for a short time only. Here the ground, below the depth of two or three feet, remains permanently frozen. The growing of crops is prohibited by the short summers, and even trees are absent. The only form of vegetation that thrives is the reindeer moss.

As animals depend upon plants or other animals for food, these regions have a limited fauna as well as flora. Here, then, there are no farms, no forests, no mines, no railroads, no cities—in a word, none of the conditions essential to the development of industry and commerce. The unfortunate inhabitants, few in number, wage a never-ceasing warfare with nature, and as a result secure the means of a bare existence.

Temperate Zone Climate.—As is indicated by the name, the temperate zone is the belt of the earth's surface which suffers neither extreme of temperature, and yet the temperature ranges are greater in this zone than in the others. The rays of the sun fall less directly than they do in the tropical zone, and more directly than they do in the frigid zone. Variations in the length of day and night are greater than they are in the tropical, and less than they are in the frigid zone.

The climate of the temperate zone is subject to extremes of

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[1] Salisbury, R. D.: "Physiography," Advanced Course, p. 525.

temperature. This is in part due to the large land area in this zone. As snow and ice are absent, except at high altitudes, during the summer months, and as land heats rapidly, high temperatures result. During the winter the land radiates its heat rapidly, and this loss of heat causes low temperatures.

These climatic conditions have led to the highest development of mankind. Generally speaking, the summers are not enervating, and the season for growth and work is long. The winters are sufficiently long and severe to make definite preparation for them a necessity, yet not so severe as to put a stop to all industry. "In the temperate zone all is activity, movement. The alternations of heat and cold, the change of seasons, a fresher and more bracing air, incite man to constant struggle, to forethought, to a vigorous employment of all his faculties. A more economical Nature yields nothing except to the sweat of his brow; every gift on her part is a recompense for effort on his. . . . Invited to labor by everything around him, he soon finds, in the exercise of his faculties, at once progress and well-being."[2]

Climate Upon Mountains.—Temperature falls on the average 1° F. for each 330 feet of ascent. There are therefore *altitudinal* as well as *latitudinal* zones. In Mexico orange, lemon, palm, and banana trees, coffee, cotton, sugar-cane and rice are grown within a comparatively short distance of mountains permanently snow-covered. In ascending these, and other mountains similarly situated, the traveler passes through all climatic and vegetation zones from tropical to frigid.

The summits of all lofty mountains are in the altitudinal frigid zone, and consequently are not climatically adapted to support life. The low barometric pressure on high mountains prohibits people in countless cases from ascending them.

To a considerable altitude the climate of most mountains is moist, for their low temperatures, actual and relative, favor condensation. At great altitudes little water vapor can be held in the atmosphere because the very low temperature reduces the capacity for water vapor.

Ocean Climate.—The ocean, except in very high latitudes, never freezes. It follows from this that the layers of air close to the ocean have a much higher winter temperature than they would otherwise have. Water, being a poor conductor, warms as slowly as it cools.

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[2] Guyot, Arnold: "Earth and Man," p. 269.

Hence the summer temperature of air adjacent to the ocean is never high. In other words, the climate that obtains upon the ocean is not subject to great extremes in temperature. It is *equable—oceanic* as opposed to *continental.*

The seasonal isothermal charts show how slight is this range of temperature. As a result of the slight range, the windward coasts of continents and islands have equable climates. The British Isles furnish a striking illustration. The coastal portion of British Columbia, although far to the north, has a climate that is essentially oceanic.

While rainfall conditions are not nearly so well known upon the ocean as they are upon the land, it seems clear that the average precipitation is less than upon the continents. The surface being uniform, one great cause of condensation is removed. The course of the winds is much more regular over the sea than over the land, for there are no surface features to deflect them. As there is nothing to check the winds, their velocities upon the ocean exceed those upon the land.

Climate on East and West Coasts.—We are now in a position to understand why there are such great climatic variations between east and west coasts. The prevailing westerly winds bring to west coasts in the temperate zone oceanic conditions of climate. The same winds, after having blown across hundreds or thousands of miles of land surface, carry to eastern coasts continental conditions—that is, high temperatures in summer and low temperatures in winter.

Along west coasts in the temperate zone the windward sides of the mountains receive an abundant rainfall, and are usually forested, while their leeward slopes and a considerable area beyond are deficient in rainfall. The great central valley of California and the eastward slopes of the Sierras and the Rocky Mountains well illustrate this.

In the tropical zone the more uniform climatic conditions and the more abundant rainfall are found on the east coasts, for it is these coasts that are first encountered by the trades as they come in contact with the continents.

Climate in the Interior.—Owing to the lack of the moderating influence of water, climate in the interior is subject to much greater temperature ranges than it is on either coast. A comparison of the July and January isothermal charts will show this to be a fact. The greater the area the more variable is the climate. North

America shows greater extremes than does Europe, and Asia shows greater extremes than either.

The interiors of continents, even though not surrounded by mountains, are, outside of the doldrums, dryer than the coastal regions. The great Western Plateau and the High Plains are examples in our country, while Asiatic Russia is another excellent illustration.

Permanency of Climatic Conditions.—There is abundant proof that much of the Great Central Plain in our country was once for a long period of time covered by glaciers. The same is true of western Europe. This shows that in these areas the climate was, during the glacial period, very different from what it is today. The fossil forms of plants and animals found in many parts of the world prove conclusively that great changes in climate have occurred. These changes represent hundreds of thousands, and probably millions, of years.

That climate is subject to considerable changes within the ordinary span of human life is a very common belief. Elderly people are prone to state that climate is quite different from what it was in the days of their youth. "The records furnished by the Weather Bureau at San Francisco cover a period of 62 years. The mean annual rainfall for the period is 22.83 inches. The average annual precipitation for the first ten-year period is 21.84 inches; for the second, 26.58; for the third, 22.93; for the fourth, 25.06; for the fifth, 20.51; and for the sixth, 21.05. The maximum ten-year average is about ten per cent. greater than the mean annual rainfall, while the minimum ten-year average is about ten per cent. less than the mean annual. The figures show definitely that there has been neither a regular increase nor decrease in precipitation."[3] A similar study of the climate of several other points in California brings out the same fact.

It seems evident that the climate has suffered no appreciable change since the establishing of the Weather Bureau Service in this country or in any European country. It appears that the northern limits of the grape vine, the olive and fig trees have remained practically unchanged in Europe since the beginning of the Christian era. In speaking of the close relation between the distribution of these forms of life and the position of the isotherms, Shaler says: "So close is this relation that meteorologists are fairly justified in the assertion that no change in the average annual temperature

[3] Chamberlain, James F.: "School Science and Mathematics," vol. xii, p. 760

of Europe to the amount of one degree Fahrenheit has taken place in two thousand years."[4] Variations in rainfall and temperature have occurred, but these have been in both directions from the normal. We may expect these variations in the future just as we have experienced them in the past. There is every reason to believe that the laws that have governed climatic conditions for untold centuries will continue to be operative for centuries to come. If the climate of a given area ever changes radically, as it may, the change will in all probability come about so slowly as not to be appreciable except by the study of written records of the change.

STUDIES

Why is climate such a powerful factor in the environment of man? Point out some ways in which man has in a measure overcome the influence of climate. Why do places in the same latitude have different climates? Is there any evidence that climate is changing? Give definite illustrations of the influence of climate upon the life of man in your vicinity.

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CHAPTER IX

Mountains and Their Relations to Life

Distribution of Population.—The total area of our Rocky Mountain and Pacific Coast states is 1,120,113 square miles, or about one-third of the area of the entire United States, exclusive of Alaska. According to the census of 1920, the population of this immense area was but 8,899,811.

Fig. 151 shows that nowhere in this area is the population dense. In fact only about 38 per cent of the total population of the United States is found at altitudes greater than 1,000 feet. In other words, mountains, as a rule, greatly restrict settlement. There are several reasons for this. With increase in altitude there is a decrease in temperature amounting on the average to 1° F. to each 330 feet of ascent. According to this general law, the mean annual temperature on the top of Mount Etna is $33\frac{1}{3}$° F. lower than that in the city of Messina, not far from its base.

As we have seen, the greater the distance from the surface of the earth the less the barometric pressure. At the altitude of 16,000 feet the pressure is about one-half of the normal at sea level. Through the process of expansion air loses heat. As the air is warmed chiefly by the heat radiated and reflected by the earth, the atmosphere on lofty mountains receiving heat from a relatively small land area is, for this reason, cooler than the atmosphere near sea level.

The highest mountains in the tropical zone rise above the snow line, and hence are incapable of directly supporting human life. The restricted areas suitable for agriculture, as well as low temperatures, discourage settlement. In Norway, owing to the mountainous character of the country, only about 5 per cent. of the land can be tilled.

Human beings cannot endure with ease such barometric pressures as exist far from the level of the sea. At altitudes greater than 12,000 feet most individuals suffer, and there are in the aggregate many persons who cannot live at altitudes of 5,000 feet above the sea.

While as a rule highlands are sparsely populated, there are marked exceptions. In the humid parts of the tropical zone, high mountains present temperate or frigid conditions, according to altitude. They are therefore in some cases more densely populated than the plains.

About two-thirds of the total population of Mexico is found upon the plateaus and mountains. The larger part of the population of Columbia, Bolivia, Ecuador and Peru is found at altitudes varying from 6,000 to 14,000 feet.

Isolation of Mountain Peoples.—The work of establishing and maintaining roads in mountainous regions is difficult and costly. This isolation, with its resulting lack of contact between the people of

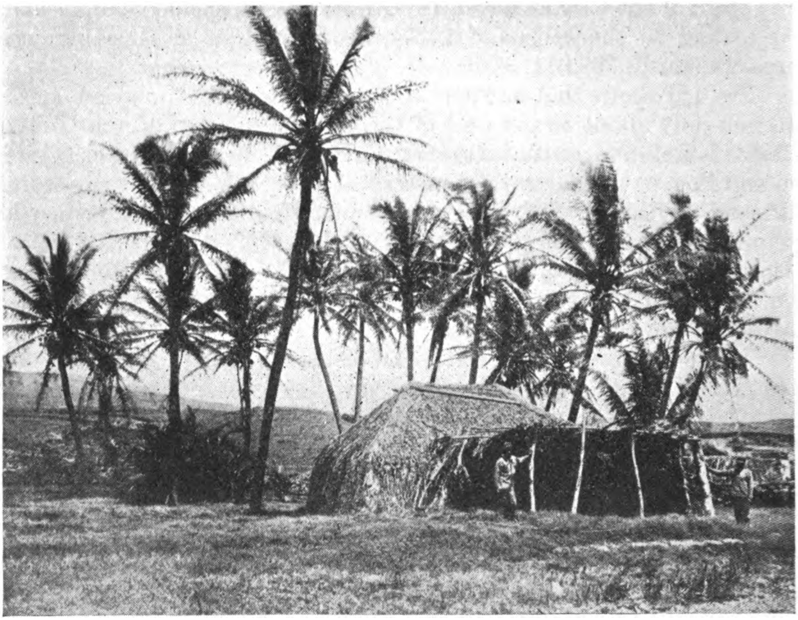

Photo by C. C. Pierce.

FIG. 27.—Life in the tropical zone.

the mountains and those of the plains, retards the development of mountain people. Customs and traits of character change slowly. Words remain in use long after they have become obsolete in the districts from which the people of the mountains originally migrated.

In the most mountainous parts of our Southern States some 300 words are in common use that have been obsolete in England since the sixteenth century. A very interesting illustration is found in Wales, where there are several hundred thousand people who cannot speak English. The Plateau of Tibet furnishes a very striking example of the influence of isolation.

Mountains and Industry.—As has been shown, agriculture upon a large scale does not exist in mountainous regions. As rainfall increases with altitude up to 6,000 or 7,000 feet, pasturage is often better upon mountain slopes than it is in the dryer valleys. In some of the densely populated countries of Europe and Asia practically

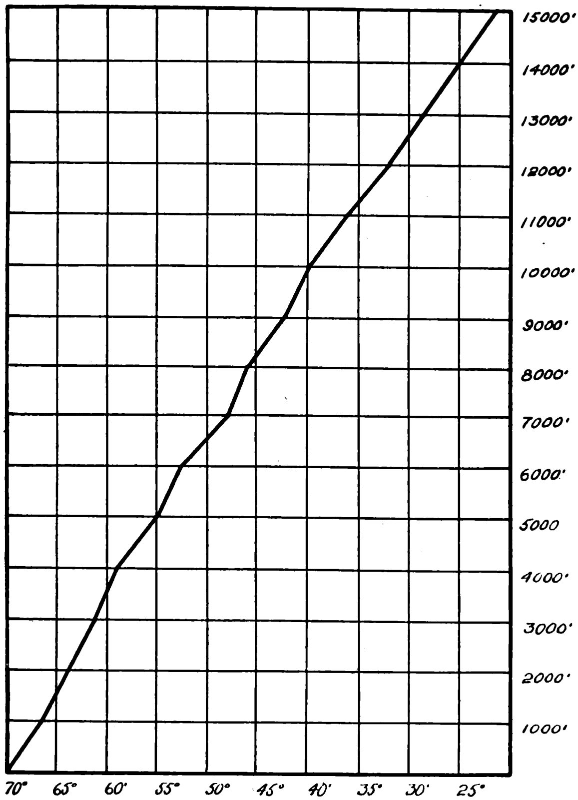

FIG. 28.—Graph showing relation between temperature and altitude.

every bit of tillable land is needed and used. As the summer advances flocks and herds are driven upward to feed upon the mountain pastures. A considerable number of persons accompany the animals to care for them and to carry on the industry of dairying. In the autumn a downward migration takes place. These seasonal movements are important in Norway, Switzerland and Austria.

Where the grass is not all eaten by the animals grazing upon the mountains, the greatest care is used to cut and dry it and carry it to the barns in the valleys for winter use. So valuable is the crop that grass in the most out-of-the-way places is cut, tied up in bundles, and rolled down the slopes. "In Switzerland not a spear of grass escapes. In places inaccessible to cattle and goats, the peasant gathers hay by the handful, with campons on his feet, generally from the ledges of cliffs. He stacks it in one spot, and brings it down to the valley by sledge in winter."[1]

Owing to the humidity and lack of sunshine in the valleys, special pains must be taken to dry the grass. Sometimes the shepherd and his wife turn the grass with forks and rakes almost constantly, and sometimes it is placed upon racks or stakes driven into the ground. This allows the air to circulate freely about it.

Mountains are the great storehouses of mineral wealth. During the process of mountain building, fissures are formed in the rocks. These enable surface water to penetrate to great depths where the temperature is high. Here minerals and metals are dissolved, and the hot water, working its way upward, carries them in solution. As the temperature of the water falls, now one substance and now another is precipitated. Thus mineral veins originate.

Although a very large part of our mineral wealth comes from mountains, it must not be supposed that all minerals are found in mountainous regions. This is far from being the case. Fig. 136, showing the distribution of coal in the United States, illustrates this.

It was the lure of gold which for many years following 1849 drew people from all parts of the world to California. The gold-mining industry was one important factor leading to the early completion (1869) of the first transcontinental railroad. The great gold strikes in South Africa, in Australia, and in Alaska are familiar examples of the influence of mineral wealth upon the movements of people and upon industry.

Mountains and Forests.—The increase in precipitation up to moderate altitudes leads, especially upon the windward slopes, to the growth of forests. Partly because of the relative inaccessibility of mountains and the distance from markets, much timber yet remains in mountainous districts. In some areas there is considerable local demand for timbers to be used in supporting the roofs and walls of mines.

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[1] Semple, Ellen C.: "Influences of Geographical Environment," p. 576.

Mountains and Water Supply.—Forests upon mountains have a value because of the timber which they are capable of supplying, and also because they are regulators of stream-flow. They check floods (see p. 262), and render streams navigable for a larger part of each year than they would otherwise be. The more regular and dependable flow of water means much to those who irrigate and to those who develop water-power. In a smaller way mountains supply water to cities. New York City, San Francisco and Los Angeles, Rome and Vienna, are good illustrations of this.

Floods result in the silting up of streams, thus gradually causing them to become unnavigable. Floods cause great loss of life and property, and for this reason steep slopes should not be denuded of vegetation. China, Italy, Spain, France and our southern Appalachian region have suffered because of floods which the removal of timber has aggravated.

Mountains as Barriers.—In many cases mountains serve as natural barriers between countries. The Alps have always made communication between Italy and the countries that surround her much more difficult than it would otherwise have been. To be sure, many invasions from the north have occurred. These were favored by the relatively gentle northern slope and the steep south slope of the mountains. The direction of movement here, as in other mountains, is closely related to the position and the altitude of the passes. The construction of tunnels through the Alps has done much to facilitate land commerce between Italy and the north, and to increase travel as well.

The lofty Himalayas, the "abode of snow," separate India and China. Most of the passes are so high that they are snow-filled permanently. Not a railroad crosses the system, although the English have built a line to Darjeeling, the altitude of which is about 7,000 feet. From this point a wagon road leads to the frontier of Tibet.

The most important mountain barrier in western Europe is the Pyrenees, separating Spain and France. The importance of this barrier is strongly brought out by the fact that there is not a railroad actually crossing the system. At the western extremity of the mountains, just back from the shore of the Bay of Biscay, is the Bayonne-Burgos Railroad. At the east end of the system is a road connecting Narbonne and Barcelona. There are several highways across the mountains. One of these passes from the valley of the Rio Ter on the north to that of the Segre, and makes use of the pass called the Col de la Perche, which has an altitude of 5,280 feet. Another follows the route of an old Roman road from Saragossa to Oloron, using the Canfranc Pass, 7,520 feet in altitude. Along these routes railroads are being constructed.

Yet another excellent example is furnished by the Caucasus Mountains, which form a great double wall about 750 miles in length, and averaging about 130 miles in width. The Terek River, which flows northeastward, leads, at about the middle of the system, to

Photo by M. L. Gibbons.

FIG. 29.—Transportation in a mountainous region.

the Dariel Pass, 7,503 feet above sea level. No other pass across these mountains is usable during the whole year; hence its importance has been great from the earliest times. The Russians have built a military road through this pass connecting Vladikavkaz and Tiflis.

"The Pass of Belfort is the strategic key to Central Europe. Here Napoleon repeatedly fixed his military base for the invasion of Austria, and hither was directed one division of the German army in 1870 for the invasion of France. The gap is traversed today by a canal connecting the Doubs and the Rhine, and by a railroad, just as formerly by the tracks of migrating barbarians."[2]

Mountains and History.—When mountain systems extend in a general way at right angles to the direction of the prevailing winds they separate areas that differ strikingly in climate, and therefore in human conditions. The Sierra Nevada of our own country are a good illustration. The prevailing westerly winds as they strike the western slope of these mountains are forced to ascend, and in so doing chill to the point of condensation. (This applies almost exclusively to the winter season.) As a result, we find upon the western slope dense forests and lumbering as an important occupation.

The abundant precipitation, amounting in places to 100 inches annually, gives rise to many rivers. These, although not navigable, furnish great possibilities along the line of water and electrical power. In fact much power has already been developed. The streams, having steep gradients, carry large loads of rock waste, and some of the most beautiful canyons in the world have resulted from the erosional work of the streams. The Yosemite Valley is but one of many such canyons.

Much of the water carried westward from the Sierra Nevada is used in irrigating the Central Valley of California. Owing to lack of precipitation during the summer, vast areas now devoted to fruit-growing and general farming would be practically useless, and the population that could be supported would be very small, but for the transference of water from higher to lower levels.

On the eastern side of the Sierra Nevadas, and west of the Rocky Mountains, stretches an immense area in which the total population is very small. This is a part of what was formerly known as the Great American Desert. The winds, robbed of their moisture on the west side of the mountains, blow over this area as drying winds. Such forms of vegetation as exist here are adapted to desert conditions. The same is true of the animal life. Only where water has been developed and irrigation is practiced, is there any considerable population.

As the winds strike the high wall formed by the Wasatch Mountains considerable precipitation in the form of both snow and rain takes place. The water from the resulting west-flowing streams was, by the early Mormon settlers, carried to the lake plains lying

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[2] Semple, Ellen C.: "Influences of Geographic Environment," p. 540.

west and south of Great Salt Lake. This was the first area in the United States to be farmed under irrigation. Our government Reclamation Service has done and is still doing wonders by way of reclaiming portions of this and other arid regions in the United States. The same dry conditions with lack of high development are found east of the Rocky Mountains. "Our western mountains render 600,000,000 acres unfit for agriculture."[3]

Another instructive illustration is furnished by the Caucasus Mountains. The precipitation upon the southern slope is greater than it is upon the northern, and owing to the sheltering influence

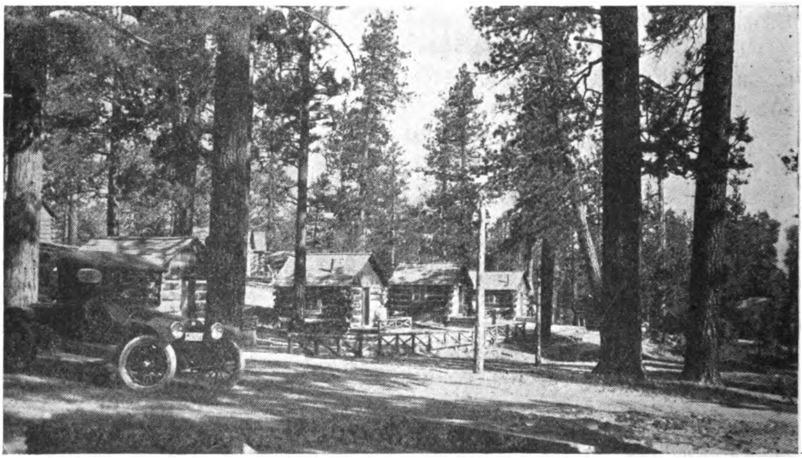

FIG. 30.—A mountain resort.

of the lofty mountains, the average temperature is higher. As a result, we find grazing to be the leading occupation on the north. The population is sparse, and industry is not developed. On the southern slope there are orchards of peach, apricot and other fruit trees, and vineyards are numerous. Agriculture is in a flourishing condition, and the land supports a considerable population.

Mountains as Health and Pleasure Resorts.—In many parts of the world the summer temperatures upon mountains attract large numbers of persons to the heights. Not only is the lower temperature favorable, but the low humidity and the greater freedom from

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[3] Whitbeck, R. H.: *Journal of Geography*, vol. 9, p. 54.

dust and other impurities, and the high percentage of sunshine, are conditions of great importance. Many go to the mountains to regain health, and a large number go as a matter of relaxation from business cares, and to avail themselves of the pleasures of hunting, fishing and mountain climbing.

Colorado has become a national playground. Colorado Springs, Manitou and other places owe their importance very largely to climatic conditions and to near-by scenic features. Our national

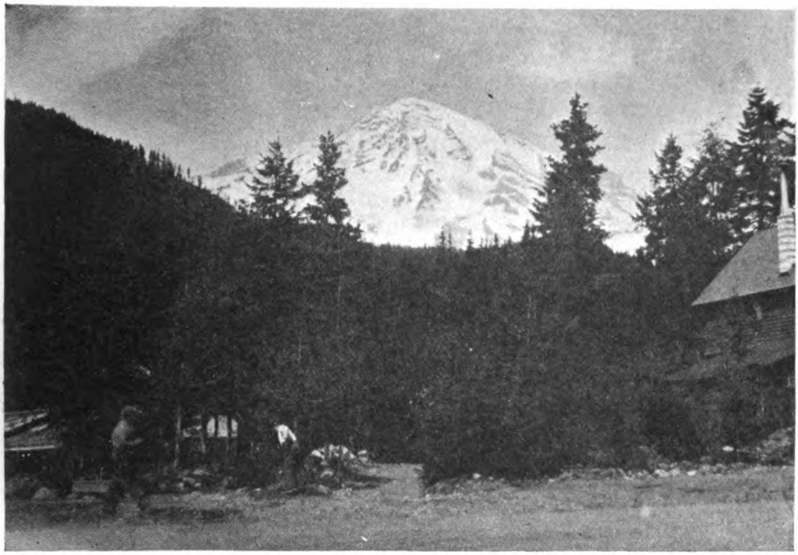


Photo by Chamberlain.

Fig. 31.—Influence of mountains upon temperature.

government has fully realized the importance of these natural playgrounds, and has set aside many areas, such as Yellowstone National Park, Glacier National Park and Mt. Rainier National Park, to be forever the property of the people of the United States.

Switzerland is an international playground. Here every summer one may meet people from every corner of the earth who have come to enjoy the glaciers, lakes, streams, waterfalls, lofty mountains and the general stimulating and uplifting effect that comes from living amid these scenes. It has been estimated that Switzerland, a country about twice as large as the state of Massachusetts, receives $60,000,000 per year from tourists. The importance of this is more fully realized when one remembers that Switzerland is not important agriculturally, and that she has practically no mineral resources.

In European Russia one may travel for hundreds of miles and not see a single hill to break the monotonous level of the land. This area is a part of the Eurasian Plain, the largest in the world. In our own country we find the second largest plain. The Amazon, between the Peruvian border and its mouth, a distance of nearly 2000 miles, falls only about 35 feet. The Amazon Plain differs from the other two mentioned in that it is forested. On the other hand, some countries, such as Norway, Spain and Japan, are very mountainous. Why do we have these great areas of practically level land, while other regions are so rugged and broken?

Origin of Mountains.—Mountains, because of the abruptness of their slopes and the altitude of their crests, are the most conspicuous and impressive of the physical features of the earth's surface. However, the most lofty peak in the world (Mount Everest, about 29,000 feet in altitude) is insignificant when compared with the radius of the earth.

Where the rocks of which mountains are composed are exposed, as along the walls of canyons, it is seen that they are seldom in a horizontal position. The rocks are either *folded* or *faulted*. In either case it is evident that tremendous pressures have been exerted to bring about these results. People living in mountainous regions are occasionally made aware of these earth movements in the form of earthquakes and volcanic eruptions. Aside from these disturbances, the great movements that result in mountain systems go on so slowly and so quietly that the dwellers in the regions are not aware of them.

Earthquakes.—An earthquake is transmitted in the form of waves which travel in all directions from the center of the disturbance, known as the *centrum*. This is usually several miles below the surface of the earth. As a result of earthquakes, cracks may be found in the rocks, buildings may be damaged or demolished, and railroad tracks may be slightly shifted. The shock travels with great rapidity, the velocity depending upon the density of the medium transmitting it.

The frequency of earthquake shock in Japan is one of the several reasons for the extensive use of bamboo as a building material. Just as we are learning to erect fire-proof structures, so we are learning to erect buildings which will withstand very violent earthquakes.

An earthquake shock originating beneath the sea would first reach the shore through the rocks of the ocean floor, next through the water, and lastly through the air. In the shore-waters a wave, incorrectly called a tidal-wave, is sometimes produced. This may do great damage to shipping and to other property close to the coast.

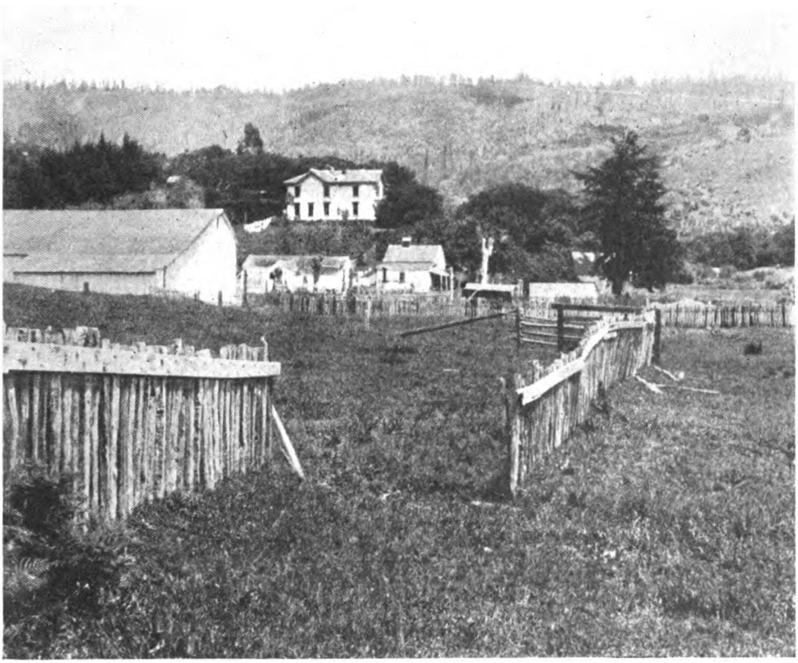


FIG. 32.—Offset fence for earthquake in California.

Earthquakes are most frequent in those areas which are geologically young.

When earth movements take place very slowly in a *geological* sense the rocks are likely to fold into great ridges with depressions between. The up-folds are known as *anticlines*, and the down-folds as *synclines*. The Appalachian and the Jura are good illustrations of folded mountains. When the movements take place quickly in a *geological* sense the rocks are likely to break, producing *faults*. Good illustrations of faulted mountains are the Sierra Nevada, the

Wasatch, and the Block Mountains of Nevada. These are in reality great blocks of the earth's crust lifted higher on one edge than on the other.

Sometimes great masses of lava start toward the surface, but do not break through the superimposed crust. Instead, the rocks above are arched up and the lava spreads out below. Such mountains are commonly dome-shaped. They are called *mountains of*

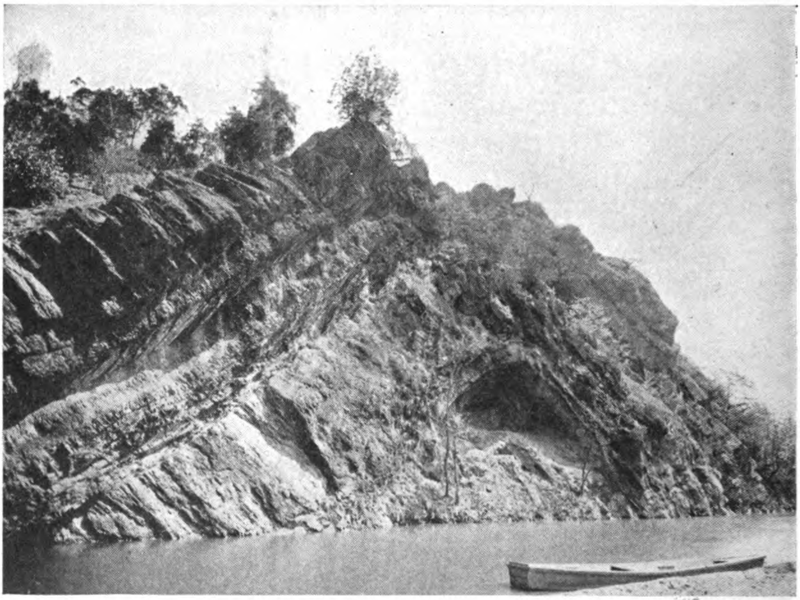


Fig. 33.—Anticlinal fold in sandstones and shales near base of Upper Silurian, Maryland.

intrusion and *laccoliths*. The Henry Mountains of Utah, the Black Hills and the Adirondacks are mountains that were formed in this way.

In some cases plateaus have suffered erosion to such an extent that the less resistant rocks have been removed, leaving the more resistant masses standing in the form of ranges, ridges and peaks. Such mountains are called *mountains of erosion* or *mountains of circumdenudation*. The Catskill Mountains belong to this class.

Volcanoes.—When, as the result of an eruption, lava or fragmental materials, or both, reach the surface, a volcano is formed. The deposition, about the opening, of some of the ejected materials builds up a cone, which in time may become a mountain. Thus, a volcanic mountain is the product of volcanic action. Such mountains may be very lofty, as Aconcagua in Chile, which rises to the height of 23,000 feet, or the elevation may be very inconsiderable, as in the case of Vesuvius. the altitude of which is about 4,000 feet.

The characteristic form of volcanic mountains is that of a cone. Fujiyama in Japan and Mt. Shasta in our own country are striking examples. Until the destruction of the volcanic mountain by the agents of weathering and erosion has reached an advanced stage, the conical form is usually retained.

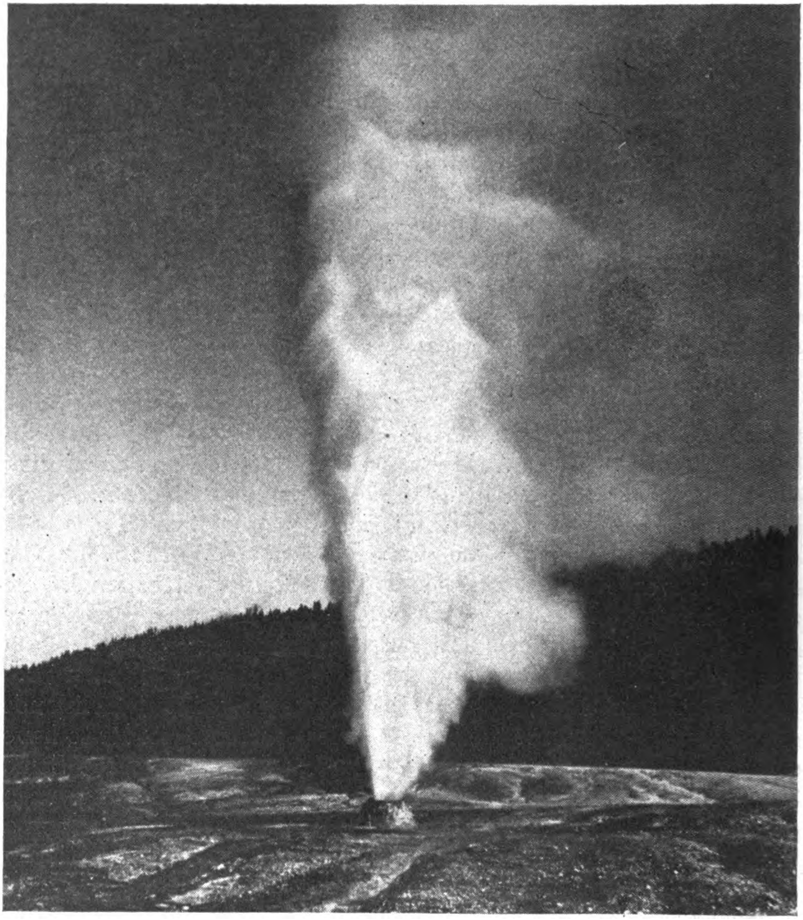
Volcanic eruptions have caused a very great loss of life and property. In some cases the eruption takes the form of an explosion, and in some it is simply a quiet outpouring of lava. Vesuvius is an explosive volcano. The volcanoes of the Hawaiian Islands belong to the non-explosive class.

Until comparatively recently the fact that lava (molten rock) flows from the earth was taken as proof that the interior of the earth is in a molten condition. At the present time the great majority of scientists do not believe this to be the case. It is believed that the temperature in the earth's interior is high enough to fuse rock *if it were at the surface.* The great pressure that exists below the surface prevents fusion. When, as a result of contraction in the rocks, the pressure along a particular line has been sufficiently relieved, rock fuses; steam and gases are liberated, and an eruption takes place.

It is an interesting fact that most volcanoes are upon islands and along the margin of the sea. A volcano that is known to have erupted during the historic period is usually classed as active. Some 300 such are known. One that has not been *known* to act, but which gives evidence of possible action, is classed as *dormant.* When a volcanic mountain has been eroded to its base and practically destroyed, it is called an *extinct* volcano.

Geysers.—In the regions subject to earthquakes and volcanoes there are many openings in the crust of the earth. By means of some of these openings water penetrates to considerable depths and becomes highly heated. Steam may be generated, and the resulting explosion ejects the water from the fissure, sometimes hurling it high in the air. The pressure relieved, water again accumulates in the tube, and in due time the eruption is repeated. The interval between eruptions from a given tube is fairly constant.

Owing to the fact that the tubes are long, narrow, and very



Haynes Photo, St. Paul.

FIG. 34.—Beehive geyser, Yellowstone National Park.

crooked, convection does not take place readily. The pressure at the lower end raises the boiling-point above 212° F. before an explosion occurs.

The placing in the tube or in the water of any substance which will check the loss of heat will hasten the geyser action.

In the geyser areas there are many hot springs. The flow of water from these is usually rather constant, and is not in the nature of eruptions. A geyser may be defined as a hot spring which erupts intermittently.

There are three well-known geyser regions, Yellowstone National Park, Iceland and New Zealand. Each summer thousands of people visit Yellowstone National Park to enjoy the unusual spectacle presented by the many geysers

As hot water is an active solvent, much dissolved mineral matter

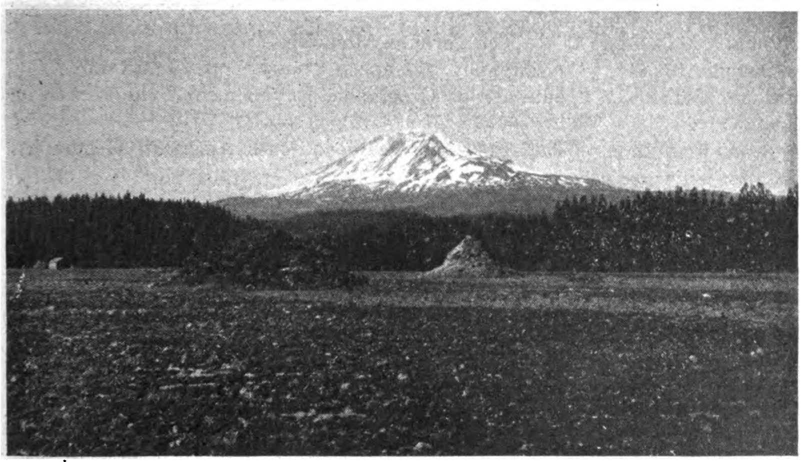


Photo by B. W. Griffith.

FIG. 35.—Mt. Adams, a volcanic cone. Note the cinder cones in the foreground.

is ejected. The cooling of the water leads to the deposition of much mineral close to the opening, thus building up a cone, mound or terrace. Some of the terraces are dazzlingly white, and are very beautiful.

"Mountains seem to have been built for the human race as at once their schools and cathedrals; full of treasures of illuminated manuscript for the scholar, kindly in simple lessons for the worker, quiet in pale cloisters for the thinker, glorious in holiness for the worshipper. They are great cathedrals of the earth, with their gates of rock, pavements of cloud, choirs of stream and stone, altars of snow, and vaults of purple traversed by the continual stars." (Ruskin.)

STUDIES

Why is the population of Belgium more dense than that of Switzerland? By means of a map trace the routes of the railroads that cross our western mountains. Show how topography has influenced the routes. If there were no mountains in the British Isles, how would the climate differ from what it is at present? Where do mountains stimulate industry? Show some of the influences of mountains upon life in Scotland. What are indications of youth in mountains? How did mountains influence the World War?

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CHAPTER X

Plains and Life

Plains and Distribution of Population.—Mountains repel settlement, but plains invite occupancy. As has been stated, about 38 per cent. of the population of the United States is found above the 1,000-foot contour. Plains, as a rule, are densely populated unless, like those of the Amazon basin, they are forested, or, like our High Plains, are deficient in rainfall. The population of India is approximately 300,000,000, about one-third of whom dwell on the deltas of the Indus and the Ganges. Upon the lowlands bordering the rivers of China there are hundreds of inhabitants to the square mile, although some parts of the republic are practically uninhabited. Holland, Belgium, the lowlands of France, Germany and the British Isles support large populations. People usually settle upon the plains as long as space is available; later they are crowded to the higher levels.

Plains and Agriculture.—As agriculture is the basal industry, and as various industries are closely associated with it, the lands that are best adapted to farming are eagerly sought and extensively used. Except in the tropical zone, the temperatures that exist upon plains are more favorable to agriculture than are those found at higher levels. Even in the tropical zone, the lowland temperatures are best adapted to certain important plants, such as the banana, breadfruit, pineapple, cocoanut, rubber and others. Owing to less rapid radiation, diurnal variations in temperatures are less strongly marked upon the plains than upon the mountains and plateaus. This is an advantage to plant life, but on plains having a hot and humid climate it is a detriment to human progress.

The soil on the plains is deeper than that on the mountains. From the steep slopes soil is continually moving under the force of gravity and the action of plants, animals and percolating water. This slow downward movement is known as *creep*. Upon very steep slopes little or no soil clings. Streams are constantly carrying soil from higher to lower levels, and the same is true of glaciers. In all of these ways valleys are being steadily filled with rock waste unless the work of *degradation*, or downcutting, exceeds that of *aggradation*, or the building up of the stream bed. A deep soil is, of course, more favorable to agriculture than is a thin one. Moreover, the greater depth enables it to hold a large amount of water which gradually reaches the surface under the action of *capillarity.*

In the soil there are countless openings, so small that they resemble hair-like tubes. Water from the soil rises in each of these tubes, just as oil rises in a lamp-wick. The water adheres to the sides of the tubes, and in this way is gradually lifted to the surface. This action, which is called capillarity, is very important to the tiller of the soil.

The levelness of plains is a great aid in agriculture. In hilly regions the tillable areas are scattered, and are often very small.

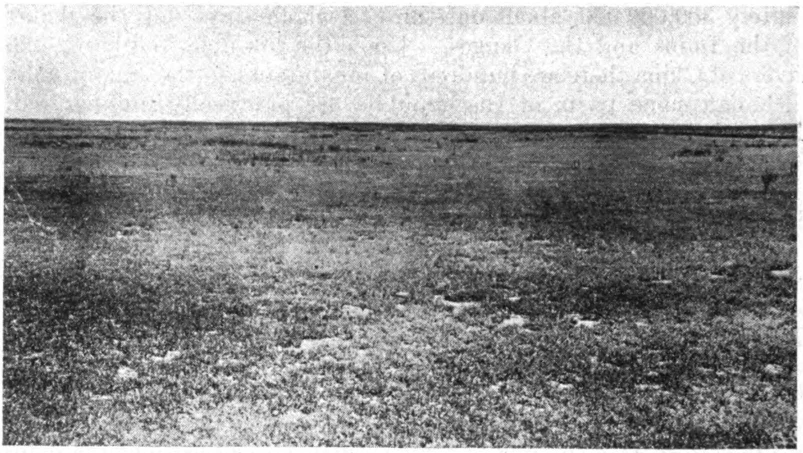

FIG. 36.—View of a prairie on the western Great Plains. (U. S. D. A.)

This practically precludes the use of machinery, and hand-tillage is resorted to. When there is a large area of level land, gang-plows, seeders, mowers, harvesters, etc., can be profitably employed. This very greatly increases the acreage that can be handled per man, hence reducing the cost of production.

Plains and the Movements of People.—Ease and cheapness of transport, whether for trade, travel or migration, is very important. Upon a prairie-plain there is practically nothing to hinder the movements of people or of produce. When our early settlers reached the prairie-plains they moved westward with great freedom. Russia has found it easy to extend eastward a peaceful conquest to the shore of the Pacific Ocean, *in part* because of the levelness of the land.

The building of highways and railways on a plain is easy and relatively inexpensive. Little grading is required, and roads follow any desired route. This means a multiplicity of roads, and consequently ample opportunity to market the products of the area. The cost of maintaining roads on level land is not so great as it is in mountains.

Another advantage is found in the fact that greater loads, in proportion to the power used, can be transported on plains. One locomotive on level land will do work for which two are required in regions of heavy grades. This means, in rugged regions, increased expense for locomotives, for fuel and for employees.

People who live on plains usually derive more benefit from streams as trade routes than do mountain dwellers. Owing to gentle slopes, the rivers flow slowly, and as they lay tribute upon a large drainage area, they are often navigable. Here, then, is a cheap means of transportation. The Mississippi, St. Lawrence, Amazon, Parana, Hoang-ho and Volga are illustrations.

Owing to ease in communication and to dense population, the inhabitants of plains are constantly in touch with one another and with the outside world. This gives them the benefit of the newest in all lines. As a result there is a tendency to broaden the horizon, and to substitute liberal-mindedness and progress for narrowness and prejudice.

The uniformity in climatic conditions leads to uniformity in plant and animal life, and hence, to a certain extent, in interests and industries. As a rule, a large area of a plain recognizes the same govermental authority. The climatic uniformity which plains present have in some cases a disadvantageous effect. This is seen in Siberia, where there is very little progress. Here the winters are so long and so severe that the enforced life within doors unfits the peasant for work when spring arrives. Owing to the marshy condition of large areas, roads are practically impassable during the summer, and cultivation is retarded until late in the season.

Origin of Plains.—When deep borings for water or for any other purpose are made in our Central Plain, rock is encountered. The rock may be struck at a depth of a few feet or a few hundred feet. In Illinois, Indiana and Iowa limestone rock underlies the surface. In South Dakota it is sandstone. As these are sedimentary rocks we have proof that the Central Plain was formed by a change in the position of land and sea areas. *Fundamentally*, plains are formed by elevations of former sea floors or by the draining away of the water.

The rocks which underlie the surface of plains are more commonly in a horizontal position than are the rocks of plateaus and mountains. This shows that plains have suffered less earth movement than have the higher parts of the earth.

A plain, varying in width from a few miles to 300 miles, extends along the entire eastern coast of the United States. This plain, called the *Atlantic Coastal Plain*, was formed primarily by an uplift of part of the sea floor. This is shown by the fact that the rocks are aqueous; that is, rocks formed through the consolidation of sediments deposited in water. Similar plains are found along the borders of all of the continents, although in Africa and along the western coast of South America they are very narrow.

The disappearance of all or a considerable part of a large lake leaves exposed flat areas, formerly the lake floors. Such areas are known as *lake plains*. A shrinkage in our Great Lakes has given rise to the lake plains that border them. The remarkably level wheat lands near Lake Winnipeg owe their origin to the disappearance of former Lake Agassiz, of which Lake Winnipeg is a remnant. As the waters of prehistoric Lake Bonneville gradually disappeared, owing to increased aridity in that part of our country, the plains surrounding Great Salt Lake were formed.

Every stream carries to the sea quantities of rock waste. The amount carried depends upon the slope, the protection afforded by vegetation, the resistance of the rock or soil, the volume of the water, and the pebbles and sand (tools) carried by the stream. The amount of rock waste carried to the Gulf by the Mississippi River has been estimated to be more than 1,000,000 tons daily.

In the lower courses of the streams, especially during times of flood, the rock waste is deposited on each side of the channels. Year by year and century by century the area so built up is extended. The resulting plain is called an *alluvial* or a *stream* plain. The part of the plain that the stream wanders over during times of flood is called a *flood plain*. A flood plain is, then, part of a stream plain.

In some parts of the world, as in the central part of the United States and in central Canada, glaciers have left great accumulations of boulders, gravel, sand and mud, thus aiding greatly in the work of building up the plains.

With respect to altitude, no sharp line can be drawn between plains and plateaus. In fact some authorities call the great area west of the one hundredth meridian and east of the Rocky Mountains a plateau, while by others the term High Plains is applied. The area is higher than many that are recognized by all as being plateaus, yet it has the level surface characteristic of plains, and is much lower than the mountains that rise on the west.

This area, like similar ones in Asia, is not densely populated, because of deficiency of rainfall. Upon our High Plains the annual precipitation is for the most part under twenty inches. The work of our government in providing water for parts of this area, and the work of the Bureau of Plant Industry in bringing from the Old World plants adapted to the conditions that exist upon the High Plains is doing much to develop the region. In all such cases the pasturing of flocks and herds is the dominant industry.

STUDIES

On a map of the world or on a globe locate all of the extensive plains. Are there any of these plains that are not well-populated? Why? Which of our states are wholly plains? Compare the percentage of Iowa and West Virginia devoted to agriculture. Account for the difference. How was the plain of which Belgium is a part related to the World War?

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CHAPTER XI

Rivers and Man

From almost any point on the rim of the Grand Canyon of the Colorado River a most wonderful view is presented. The observer is standing upon one edge of what appears to be a stupendous crack in the crust of the earth. Ten miles away is the opposite rim of this immense gash. The slope from the farther rim to the bottom of the canyon is seen to be made up of a series of very steep cliffs, some of them hundreds of feet in height, alternating with more gentle declivities. The slope on the observer's side is the same, but less of it comes within his field of vision. As far as the eye can reach there is a tangle of turrets, domes, spires and peaks. A mile below is the bottom of the canyon, and upon it can be seen short stretches of the river. It is a raging torrent, yet no sound comes to the observer far above. The most wonderful section of the Colorado Canyon is some 300 miles in length. Its walls from top to bottom are of solid rock. An army, equipped with the best of tools, would work for centuries in excavating such a canyon. How could Nature have performed the work?

Destructive Work of Streams.—As has been pointed out, water flowing from higher to lower levels develops energy. The amount of this energy depends upon the distance which the water falls, and the volume of the water. The amount of erosion performed by a stream depends upon these conditions, and in addition the tools carried (the load of rock waste), the resistance of the rock or soil, and the extent of a forest or grass cover.

The water flowing in the Colorado River falls thousands of feet before reaching the Gulf of Lower California. Its power to erode is therefore very great. As the Colorado flows swiftly, it is not easily thrown from side to side by obstacles. It therefore deepens its valley more rapidly than it widens it. Erosion on the bed of a channel is often called *corrasion.* A stream that is constantly surging from side to side undercuts its banks, and great masses of earth and rock fall. Such a stream widens its valley faster than it deepens it.

In an arid region a river has few tributaries, hence there are few tributary or *entrant* valleys. Aridity is therefore another cause for slowness in valley widening. The Colorado Canyon has been cut in a lofty plateau, the rock layers in which are practically horizontal. As the river is working upon one stratum of rock at a time, it is eroding material fairly uniform in resistance. There is therefore less undermining of the sides of the valley than would be the case were the strata tilted.

As a result of the swiftness of the current, aridity of the climate, and horizontal position of the rocks, the Colorado has developed a valley the depth of which is great in proportion to its width. Such a valley is called a *gorge* if small; a *canyon* if large.

Century by century, as the Colorado continues its work, its valley will be cut deeper into the rock. As no stream can cut any part of its valley much below the level of the body of water into

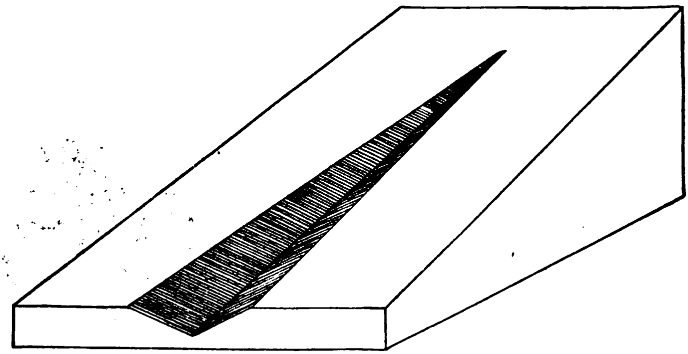
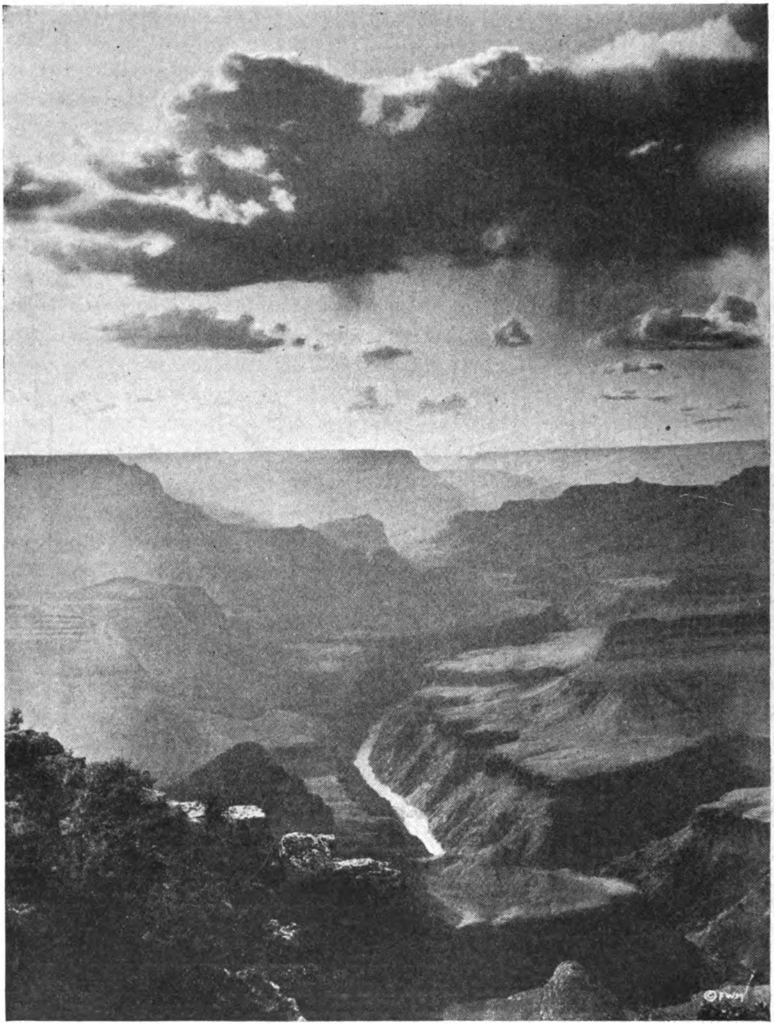


FIG. 37.—Up-stream development of a gully.

which it flows (this level is known as *base level*), it is evident that the limit of deepening will eventually be reached. Base level is reached at the mouth of a stream before it is reached at points nearer the source. Hence a valley develops from the mouth of its stream upward on to the land.

Although side-cutting is not being carried on extensively in the Colorado, valley widening is always in progress. In the future the canyon will become shallower in proportion to its width. In other words, the distinctively canyon form will slowly give place to the ordinary valley form.

Little by little, then, through a period of great but unknown duration, the Colorado River has cut its way downward into solid rock. Boulders have been, by their ceaseless grinding upon one another and upon the bed of the stream, reduced to pebbles, sand



F. W. Martin, Pasadena.

FIG. 38.—The Grand Canyon of the Colorado.

and mud. Most of this material has been deposited in the Gulf of Lower California. The work of lowering the surface of the land is being carried on by every stream, no matter how small it may be. If you will think for a moment of streams as having a definite purpose, you may perhaps more fully realize the significance of the following statement: "It may therefore be said that *every drop* of water which falls upon the land has for its mission the getting of the land into the sea."[1] According to reliable estimates, streams are lowering the surface of the earth at the rate of one foot in 3,500 years.

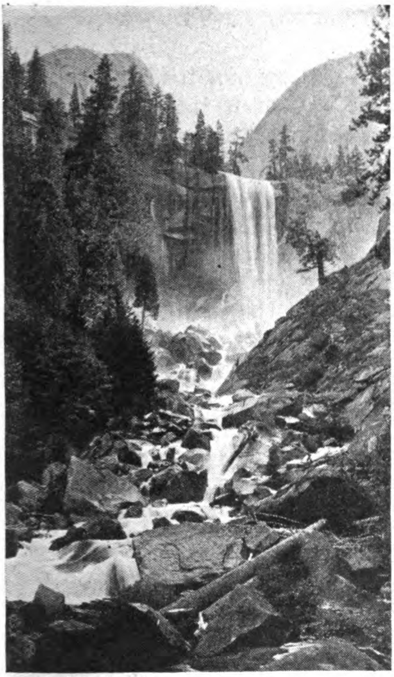


Photo by Chamberlair

FIG. 39.—Vernal Falls, Yosemite Valley.

When a stream has performed a large part of its original work, that is, has lowered most of the land in its basin to base level, it is said to be *old*. A stream that has performed only a small part of its original task is called a *young* or a *youthful* stream. These terms have no reference to years. As most of the land in the basin of the Colorado River is thousands of feet above the level of the sea, and as the river has a canyon valley, a steep gradient, and many falls and rapids, it is a good example of a *young* stream, although it has been in existence for thousands of years.

If all of the lands in a drainage basin were to be reduced to base level, the area would have completed a *cycle of erosion*. As the time required for this is so enormous, all or part of any large basin is likely to experience some uplifting before the cycle is completed. It is evident that such uplift would give the streams renewed energy, because their fall would be increased. With this renewed energy the rivers would again produce such topographic forms as are characteristic of the work of young streams. A river that has been given new life by this process of uplifting is called a *rejuvenated* stream. Some stream valleys show by their forms a record of such uplifting.

If, then, you can realize that the great Canyon of the Colorado has been excavated from solid rock by the action of running water

[1] Salisbury, R. D.: "Physiography: Advanced Course," p. 122.

aided by the tools which it carries, you will find it less difficult to appreciate the fact that all stream valleys, big or little, have been developed in the same way. Remember, then, that *stream valleys are made by the work of streams.* It is necessary to make a distinction here, for great basins, such as the one bounded by the Rocky Mountains on the west and the Appalachian system on the east, are called *valleys.* They are not stream valleys, however, their origin being due to movements of the earth crust.

No amount of book study will take the place of actual observation. Upon every slope and in every roadside ditch the opportunities to study valley development during and following rainstorms are numberless. Hence, on a small scale, can be found valleys in all stages of their history, and all the topographic forms that streams produce. It is impossible to study geography in a really vital way unless observation of nature accompanies the use of books.

Falls.—Between Lake Erie and Lake Ontario is situated one of the most marvelous sights on the face of the earth. A great wall of water, divided into two parts by an island, drops over a cliff more than 150 feet high. The roar of the falling water can be heard for a long distance when the wind is favorable, and a great cloud of spray and mist rises from the rocks upon which the water is dashed. This is the world-famed Niagara Falls.

Study has shown that at this point a bluff, known as the *Niagara Escarpment*, and composed of resistant limestone, passes from New York State into Canada. The steep face of the bluff is to the north. Centuries ago, when the outlet of Lake Erie was blocked by an ice sheet, the waters of the lake found a new outlet over the Niagara Escarpment. Thus was developed the Niagara Falls.

Inch by inch the edge of the cliff over which the water falls has been cut back, and consequently the Niagara Falls, like all other falls, works up stream. This up-stream march of falls is called the *recession of falls.* The Niagara Gorge, about seven miles long, constitutes a record of the recession of the falls, for the gorge is the result of the movement. Since 1678 the falls have receded at the average rate of from four to five feet per year. Could we be sure that the rate of recession has been the same since the falls originated, what a wonderful geological timepiece the gorge would be!

In New England, and in other glaciated areas, many falls have resulted because of the blocking of streams by the glacial deposits. Inequalities in the hardness of rock in stream beds leads to unequal erosion, and therefore to the origin of falls. Lava-flows, landslides and movements of the earth's crust are responsible for the origin of some falls.

The energy expended by the Niagara River as it makes its great leap is equal to about 5,000,000 horse-power. Few, if any, geologists believe that the gorge was formed in less than 10,000 years. Compare the work done here with that which has been done by the Colorado River. Some of the energy of this great fall is used in the form of power and light in the cities of Niagara Falls, Buffalo, Tonawanda, Hamilton, and many other places. Falls in practically all parts of the world are being used for similar purposes. Falls have another important economic bearing, because they obstruct navigation. This will be discussed in another place.

Transportive Work of Streams.—As has been stated, streams transport the loads which they acquire through their own efforts, as well as the rock waste brought to them by tributaries, glaciers, landslides and winds. The coarser material is rolled along their beds and the fine particles carried in suspension. In addition, a large amount is held in solution. Gravity aids streams in transporting their loads. It should be remembered also that the weight of a stone immersed in water is decreased by an amount equal to the weight of an equal volume of water. Upward currents, caused by the inequalities of the beds of streams, keep small particles suspended in the water while they are carried forward considerable distances.

Constructive Work of Streams.—When the energy of a stream is not sufficient to transport all of its load, a part of it is deposited. The causes of deposition are decrease in velocity or decrease in volume, or both. Checks in velocity occur all along the course of a stream, and, as a consequence, deposition occurs at practically all points. As the transportive power of a stream decreases very rapidly with decrease in the velocity, we find the larger materials deposited where the slope is steep, and the finer materials where the gradient is very gentle. When a stream flows into the sea or any large body of water, its velocity is at once checked, and deposition results.

As the flood stage in a stream passes, there is a decrease in both volume and velocity of water, and consequently sediment is deposited. In its lower course, a stream flowing over very low land may flow through several channels to the sea. As the streams in these channels distribute the waters of the trunk stream they are called *distributaries*. Along each of these deposition occurs, and the resulting plain is called a *delta*.

In addition to stream plains (p. 120) and deltas, river deposits form bars, islands, capes, hooks, spits, alluvial fans and alluvial cones. It has been estimated that the Mississippi carries annually to the Gulf sufficient material to build up one square mile to the height of 268 feet. "It would take nearly 900 trains of 50 cars each, each car carrying 25 tons, to carry an equal amount of sand and mud to the Gulf."[2]

Centuries ago the city of Adria was a seaport. Today the delta built by the Po River extends 14 miles beyond the site of the ancient city that gave the Adriatic Sea its name. The Hoang-ho, Ganges, Orinoco and Rhône are other streams which are building deltas.

Distribution of Streams.—As streams owe their origin to the rain that falls upon the earth, we find them everywhere. In regions of abundant precipitation they are numerous, unless much of the

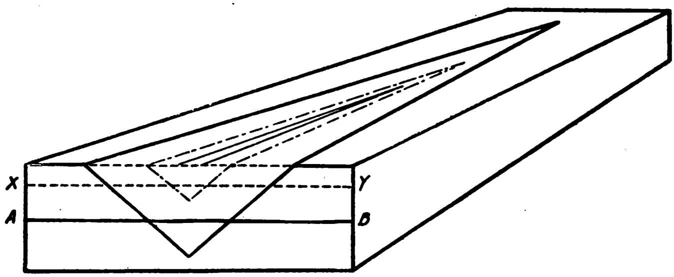


FIG. 40.—Relation of stream permanency to water level: *A–B*, water table in dry seasons; *X–Y*, water table in wet seasons.

area is in the form of marshes, but in arid regions they are scarce.

In regions of very little precipitation stream channels carry water during and for a short time after rains, but at other times they are dry. Such streams are called *intermittent streams*. There are also countless intermittent streams in every humid region. A stream will be intermittent until it has sunk its valley to the level at which water stands in the soil or rock. This level, which is known as the *ground water level* or *water table*, is at different heights in different places, and its height at a given place varies from time to time. After a stream has reached this level it does not depend *directly* upon precipitation, and is therefore a *permanent stream*.

Rain that falls upon 32 states finds its way to the Mississippi and to the Gulf. The entire drainage of eight states is poured into the

[2] Salisbury, R. D.: "Physiography: Advanced Course," p. 121.

Mississippi. The Mississippi is the *main, trunk, or master stream,* and those contributing water to it are the *tributaries.* The entire network of streams is a *river system,* and the total area drained is the *drainage basin.*

Rivers as Carriers.—"Every country of large extent finds, next to the fertility of its soil, its navigable rivers the most important factors of its early development. The one is fundamental to the production of wealth, and the other to its distribution and exchange."[3]

Waterways are of great value because of the low cost of transportation. In some cases these natural highways have been completely constructed by nature, and in all cases the work has been partially so done. The expense of keeping the waterways in repair is usually slight. The floating stock does not deteriorate rapidly as a result of use, and the cost of motive power is reduced to the minimum. In fact, in many cases the chief item of expense is that incidental to the loading and unloading of the goods.

As a country develops, railroads take the chief place as carriers both of freight and passengers. The inland waterways are able to compete successfully only in the transportation of heavy, bulky and non-perishable goods. Hence we find in many regions well equipped with railroads that the rivers, lakes and canals transport such commodities as iron-ore, stone, coal, lumber, grain.

Our country is particularly favored in the nature and extent of its inland waterways. The Mississippi and its tributaries offer some 9,000 miles of navigable waters—a distance more than equal to the diameter of the earth. The value of these rivers becomes the more apparent when we remember that they traverse a part of the United States the value of the natural resources of which is beyond computation. The navigable part of the Mississippi alone gives river frontage to ten states.

By means of the St. Lawrence and the Great Lakes a waterway is opened to the very heart of our country and Canada. This magnificent highway is of inestimable value, for it draws upon the forest wealth of northern Michigan, Wisconsin and Minnesota, the great iron and copper deposits along the shores of Lake Superior, and the vast wheatfields of Minnesota and the Dakotas. Although the Great Lakes are closed to navigation for about four months each year, a much greater tonnage passes through the St. Mary's canal, which

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[3] Semple, Ellen C.: "American History and Its Geographic Conditions," p. 251.

connects Lake Superior and Lake Huron, than through the Suez Canal, although the latter is open the entire year, and is used by the ships of many nations.

The chief articles of freight shipped by the Great Lakes and the St. Lawrence are, in the order of their importance, iron-ore, coal, grain, lumber and flour. Practically all of the iron-ore shipped by water in the United States is carried on the Great Lakes. It is shipped from Duluth, Two Harbors, Superior, Ashland, Ironwood, Marquette and Escanaba to Chicago, Gary, Detroit, Cleveland, Ashtabula, Erie and Buffalo.

While the movement of iron-ore is eastward, the coal is carried westward. This comes from the Pennsylvania and Ohio coal fields. Erie, Pennsylvania, and Cleveland, Ohio, are important shipping points, and the coal is unloaded at various points on Lakes Michigan and Superior. Like the iron-ore, the grain and flour move eastward. The chief shipping points are Duluth, Superior, Chicago and Milwaukee. Much of the grain is exported, reaching the Atlantic coast by way of the Erie Canal. Although the amount of lumber shipped on the Great Lakes is large, it is steadily decreasing, because our forest resource in the lake region is becoming depleted. Chicago is our greatest lumber market, serving as a point of distribution for a large and populous area.

The value of a river as a means of transporting goods and people depends in a large measure upon its depth. For a considerable distance from the sea the St. Lawrence is an estuary. In places the river reaches the depth of 800 feet. At the mouth of the Saguenay it is nearly 200 feet deep. The head of navigation is found at Montreal, 600 miles inland, where the depth is 30 feet. Between Montreal and Lake Ontario there are various rapids around which canals have been constructed.

Centuries ago the seaward portion of the St. Lawrence valley subsided below the level of the sea. The waters of the sea then penetrated the valley, filling it with water to a great depth. This part of the St. Lawrence valley is therefore called by geographers a *drowned valley*. This is a striking illustration of how the forces of nature influence the life of man.

The Hudson valley, as far as Albany, is a drowned valley. Although small, the Hudson is of tremendous economic value. Its great depth (due to drowning), and the comparative ease with which it was connected by means of the Erie Canal to the Great Lakes, has made it one of our most important lines of trade.

The Amazon, the largest river in the world, is a great water-highway, although owing to the undeveloped condition of the country it does not bear as great a commerce as does the much smaller Rhine. "The main stream of the Amazon is about 4,000 miles, or 600 miles longer than the distance from Liverpool to New York. It has 29 large tributaries, each a great river in itself. It offers a means of inland navigation for more than 20,000 miles. The source of the river is only 60 miles from Lima, near the Pacific coast. It thus is seen practically to cross the continent of South America from west to east, and that at a place where the continent is almost at its widest. It leads through a vast region, supplying rubber, chocolate, hides and tropical woods, which would be of little use to man were it not for this great pathway, for the tropical forest is all but impenetrable away from the river courses that offer natural highways."[4]

It is difficult to realize how flat is the region drained by this great river. From a point 500 miles from the sea the Amazon falls on the average but one-eighth of an inch to the mile. At the distance of 2,000 miles from the sea the altitude of the river is but 35 feet. This low gradient is a great advantage to navigation. Unlike the St. Lawrence, which is closed by ice from December first to May first, the Amazon is never so obstructed.

The Parana offers thousands of miles of water communication. Ships drawing 21 feet can ascend to Rosario, 230 miles from Buenos Aires. Those of 19 feet draught reach Santa Fé, a distance of 350 miles. Vessels drawing 15 feet can ascend 850 miles, and those requiring but 8 feet can penetrate the country to a distance of 2,000 miles from Buenos Aires.

The Rhine, although a relatively small stream, is one of the most important river routes in the world. During the last quarter of a century millions of dollars have been expended in improving this river. It has been deepened and made nearly uniform in width. Tugs towing from one to six barges loaded with coal or lumber may very frequently be seen. Much stone is shipped down stream to Holland, which has little of this commodity. Canals connect the Rhine with the Rhône and the Seine.

Russia has many large rivers, yet their value as lines of transportation is lessened by several circumstances. The Volga, a mighty stream, bears considerable commerce, yet it terminates in an inland sea. As a result, most of its freight is borne up stream, thus increasing

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[4] Bowman, Isaiah: *Journal of Geography*, vol. ix, p. 36.

the cost of transportation. For a part of the year it is ice-bound. The Ob, the Yenesei and the Lena, all rivers of great magnitude, empty into the Arctic, and hence are of little commercial value.

The development of Africa has been greatly retarded by the fact that her rivers break through a mountain wall before reaching the sea. There is no natural highway leading into the continent. The valley of the historic Nile is the chief route, and navigation on this river is much impeded by rapids.

Rivers and the Location of Cities.—Since the courses of trade and travel are so greatly influenced by rivers, it is but natural that the distribution of population and the location and development of cities should be affected by them.

Important cities are practically sure to grow at or near the mouths of navigable rivers. New York, Philadelphia, New Orleans and Buenos Aires are examples. Montreal, Paris and Hankow are cities that owe their prominence in part to their location at the head of deep-water navigation. St. Louis, Frankfort-on-Main, Lyons, Manaos and Pittsburgh are advantageously situated at the junction of rivers. Minneapolis, Holyoke, Spokane and Buffalo derive water-power for their industries from falls upon which or near which they are situated.

Floods in Rivers.—Rivers which are subject to serious floods often do great damage to cities along their banks, and to large areas in their basins. The Hoang-ho of China has caused most disastrous floods. The Ganges, the Po, the Seine, the Mississippi, and many other rivers are subject to flood. In the spring of 1912, and again in 1913, most disastrous floods occurred in the Mississippi and its tributaries. The loss in 1912 is estimated at $78,187,670, and that in 1913 at $163,564,793. The flood of 1913 was caused by a four-days' rain which broke all previous records in the Mississippi basin. In both cases flood warnings, which resulted in the saving of life and property, were sent out. "During the flood of 1912, according to such estimates as were obtainable, property to the value of $16,180,000 was saved, of which about $10,000,000 was in the district below Vicksburg, Mississippi. The total annual cost of the river and flood service for the entire country, including telegraph and telephone tolls, is about $80,000, or only about one-half of 1 per cent. of the value of the property saved in this one flood."[5]

[5] Frankenfield, H. C.: "The Ohio and Mississippi Floods of 1912." *Bulletin Y*, Weather Bureau, p. 24.

In order to hold back flood waters people have built walls, or *levees*, along the banks of streams subject to flood. These cause the streams to deposit material on their beds, since they cannot overflow their banks and deposit on a larger area. In time the bed of the stream becomes higher than the land adjacent to the stream, but outside of the levees. When, therefore, a levee breaks, the flood is likely to be very destructive.

Senate Document No. 84.

FIG. 41.—Sand spread over fertile lowland bordering Catawba River by flood.

Levee construction along the lower Mississippi was first undertaken by the planters. Later the state governments aided, and now the national government carries on the work. The levees must be patrolled and the utmost vigilance employed to keep them in repair. In 1875 James B. Eads established the jetties near one of the mouths of the river. These narrowed the channel, and as a result the velocity of the current was increased, and the stream carried away sediment instead of depositing as formerly.

Rivers and Water Supply.—Some streams are of great value in furnishing a water supply both for irrigation and for use in cities. Practically all streams in arid regions are important in the first of these ways. The Nile is an excellent example. Without its life-giving waters Egypt would be a desert, as is the region just beyond the irrigated land. The Indus is used extensively for irrigation purposes.

Los Angeles, California, at a cost of about $27,000,000, has brought

Courtesy Southern Pacific Co.

FIG. 42.—Railroad following river valley.

water from Owens River, 223 miles distant. San Francisco has under way a project to secure a water supply from the Hetch-Hetchy valley in the Sierra Nevada. Formerly Cairo, Egypt, took its water supply directly from the Nile, but it is now pumped from the sands below the stream. New York City at tremendous cost has brought water from the Catskill Mountains.

Rivers and Railroad Construction.—Since transportation by water is so cheap, a region having many waterways may be slow to build highways and railroads. This was true of the eastern and central parts of our country. Holland with her navigable rivers and canals has a relatively slight mileage of railroad. In our western country the absence of waterways made roads a necessity, and they were rapidly constructed. South Africa and Australia illustrate the same point.

Rivers and History.—From the earliest times rivers have guided the movements of people, and have been closely associated with history. The valley of the Rhône is a natural route of travel leading from the Mediterranean into Europe. Along it there have been peaceful and warlike movements for centuries. The Rhine is even more historic. Its course is shared by Switzerland, Germany and the Netherlands. For hundreds of years the valley of the Danube has echoed to the tramping of migrating peoples. The Orient Railway follows the valley for some distance, and the lower course of the river was an important factor in the Rumanian campaign during the World War.

Streams guided the movements of our early settlers, both in the East and as they toiled up the slope toward the Rocky Mountains. The trappers and fur traders followed up every mountain stream in their quest for pelts. The same has been true in Siberia. The valleys of the Hudson, the Mohawk and the Shenandoah were important in the Indian and later wars, and the Mississippi played an important part in our Civil War.

The St. Lawrence has left its impress upon the history of Canada, and to some extent upon that of the Unites States. Its valley guided the movements of the early French missionary, trapper and trader, while the settler built his cabin upon its banks. The importance of water frontage led to the establishment of long, narrow holdings and a concentration of population along the river. Speaking of these early conditions Parkman says: "One could have seen nearly every house in Canada by paddling a canoe up the St. Lawrence and the Richelieu."[6]

STUDIES

Compare the work performed by the Colorado and the Platte, and account for the difference. In what states in our country can little water power be developed? Have all of these states coal deposits? On a base map of the United States indicate the limit of navigation on each of the important rivers. Make a thorough study of the most important stream in your state.

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[6] Parkman: "The Old Régime in Canada," p. 297.

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CHAPTER XII

Lakes: Their Origin and Uses

Distribution.—A map of the United States shows that in some parts of our country lakes are very numerous, while in other sections there are very few. Illinois, for example, has, except in the extreme northern part, few lakes, although Wisconsin has thousands. One may travel for scores of miles in the central valley of California and not see a lake, yet the topographic sheet representing the Mt. Lyell Quadrangle (926 square miles in area) shows 40 lakes which are named, and at least twice as many not named. Scotland, Finland and Switzerland are noted for their lakes, but France, Germany and Spain are not. The explanation of the distribution of lakes is to be found in their origin.

Origin of Lake Basins.—When the great ice sheet covered Canada and much of the northern part of our country, it deposited quantities of boulders, gravel, sand and clay (glacial drift). In countless cases the drift filled or partially filled stream valleys, thus creating ponds or lakes on the up-stream sides of the obstacles.

The glacier exerted a tremendous pressure as it slowly crept forward, scooping basins out of the earth, or even solid rock, but more frequently enlarging existing basins. Upon the retreat of the glacier, the basins filled with water.

The foregoing suggests that lakes should be more numerous in glaciated than in non-glaciated regions. Fig. 46 shows that this is the case. Many lakes in New England, New York State, the north-central part of our country and Canada are of glacial origin. The same is true of most of the lakes of western Canada, California and Europe.

As we have seen, the crustal movements of the earth, *diastrophism,* produce unequal results at different points. An upward movement across the course of a stream might dam the waters, thus giving rise to a lake. A downward movement might form a basin. Faulting gave rise to the basin in which beautiful Lake Tahoe, California-Nevada, is situated. The lake is 21.6 by 12 miles in its dimensions. The surface of the lake is 6,225 feet above sea level, and the greatest depth is 1,645 feet. Surrounding the basin are peaks ranging in altitude from 8,000 to 10,000 feet. The water is so clear that the bottom can be seen at depths of more than 100 feet.

In the southern part of Oregon there is one of the most beautiful lakes in the world—Crater Lake. It occupies a practically circular basin near the top of Mount Mazama. The diameter of the basin is about five miles, and the greatest depth of the lake is nearly 2,000 feet. The walls of the basin rise very steeply from 700 to nearly 2,000 feet above the water.

The conical form of Mount Mazama suggests that it is of volcanic origin. Study shows that this is true. At some time during the

Photo by F. H. Kiser.

FIG. 43.—Crater Lake, Oregon.

volcano's history several thousand feet of the mountain sank, forming a great basin, or a *caldera*. Later action developed a cone, which now forms Wizard Island. Distinct lava flows are found upon the slopes of this island, and above are steeper slopes formed more largely of loose material. The crater, which is quite accessible, is about 150 feet in depth.

Although the lake has no surface outlet, its waters are fresh and have been stocked with fish. The porosity of the walls of the lake may permit of the escape of water, but in any event as no stream flows into the basin, and as the rate of evaporation is slow and precipitation abundant, the waters would remain fresh a very long time, if not always.

Sometimes a tributary stream, having a much steeper slope than the main stream, brings to the latter more material than it can remove. This acts as a dam on the main stream and causes its waters to spread out. Such a widened form of a river is often called a lake. Peoria Lake in the Illinois River, Pepin Lake in the Mississippi River, and Lake St. Peter in the St. Lawrence, are illustrations.

Salt Lakes.—Analysis of the waters of rivers shows that in all cases they carry some salt, so little, however, that it can seldom be detected by the taste. Unless a lake has an outlet, *all* of the salt

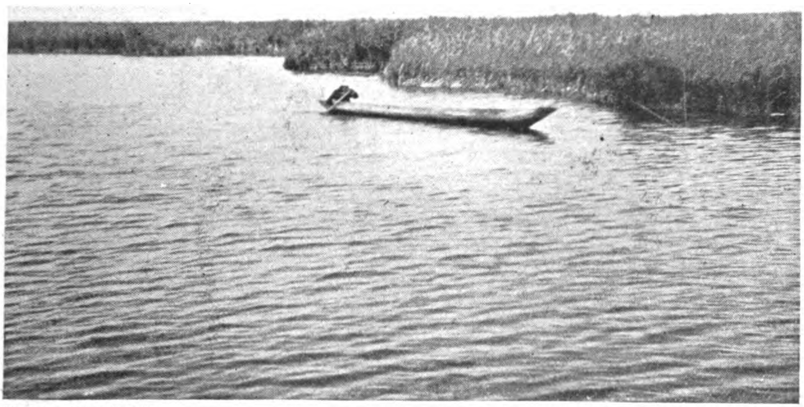

Photo by Chamberlain.

FIG. 44.—Vegetation filling Upper Klamath Lake.

carried to it by streams remains, for solids are not removed from the water through the process of evaporation. Hence, in time, the waters of such lake would become salty.

Owing to diastrophic movements the outlet of a lake might be cut off, and such a lake would eventually become a salt-water lake. Great Salt Lake is the most striking example of a salt lake in our country. Ages ago it was a salt-water lake. Then came a period of increased precipitation, and the level of the lake rose until an outlet to the Snake River was established. In time, therefore, the lake became fresh. Later through decrease in precipitation the level fell below the outlet, and once more the water of the lake became salty.

In the waters of the ocean there is about 3 per cent. of salt. In Great Salt Lake the percentage varies from 12 to more than 20.

So dense is the water that a person cannot sink in it. The Caspian, the Aral and the Dead Seas are other examples of salt-water lakes, although they are called seas.

Changes in Lake Basins.—You probably think of lakes as being permanent features of the earth's surface, yet this is far from being the case. The sediment deposited in lakes by streams slowly raises the level of the lake floors (unless a crustal subsidence is taking place), and as a result the basins are in time filled.

Photo by Chamberlain.

FIG. 45.—Lake Louise, British Columbia. A glacial lake.

As the filling process nears completion, the lake is gradually transformed into a bog or marsh. The growth of vegetation along the shore aids in the filling process. In this way many lakes are being gradually transformed into marshes. Around the shores of the Klamath Lakes in Oregon there are thousands of acres of swamp lands that are gradually encroaching upon the lakes.

If a stream flows out of a lake it lowers its outlet through the process of erosion. This work is carried on very slowly, because most of the sediment carried into lakes remains there, and consequently outflowing streams have few tools with which to work. The Rhône flows into Lake Geneva, carrying much sediment. When it issues from the lake it carries very little. The Niagara River carries so little sediment that it is unable to tear the tiny plants from the rocks on its bed. Through the double process of basin filling and outlet lowering all existing lakes will in time be destroyed.

Relation of Lakes to Man.—During the summer millions of people in our country and in Europe leave the cities to spend a few days or a few weeks in some resort. A very large number of resorts are located upon the shores of lakes. Boating, bathing, fishing and attractive scenery are among the allurements. This extensive use of lakes concerns transportation companies, hotel- and shopkeepers, farmers and dairymen who furnish supplies, and many others in addition to the tourists. Lake resorts are found in various parts of our country, and some of the most beautiful and far-famed cities of Europe are located upon lake shores. Geneva, Lucerne, Montreux and Interlaken in Switzerland, and Bellagio, Lugano and Menaggio in Italy may be mentioned.

In a few cases lakes are very important commercial routes. Our Great Lakes are the most striking examples. The Caspian Sea (which is in reality a lake), Lake Geneva, Lake Constance and Lake Titicaca have some commercial value. The importance of frontage upon a large lake is illustrated by the fact that Congress so fixed the boundaries of Illinois and Indiana that each state should have some frontage on Lake Michigan.

In the southern peninsula of Michigan large quantities of peaches are grown. Many are shipped by rail and boat to Chicago; for northern Illinois, although in the same latitude as the peach-growing area in Michigan, does not produce this fruit. During the summer large numbers of people go from Chicago to resorts on the Michigan side of the lake. Both of these conditions are due to the influence of Lake Michigan upon the climate.

Water, being a poor conductor, heats and cools slowly. Lake Michigan never freezes over, because the entire volume of water (the maximum depth of the lake is approximately 1,000 feet) would have to be reduced to a temperature of 39° F. before *any* of it could freeze. This would take so long that freezing occurs close to the shore only.

During the winter, then, the eastern shore of Lake Michigan is benefited by the relatively moderate temperatures of the waters of the lake. This prevents trees from winter-killing. As spring advances and the land warms, high temperatures on the Michigan side are prevented by the cool winds from the lake. This prevents the fruit trees from blossoming as early as they do on the west side and they are therefore less liable to be injured by spring frosts. The land winds that blow over Chicago bring high temperatures in summer and low temperatures in winter. As a result the eastern shore is the better adapted to resorts.

Many lakes are of value because they furnish an abundant supply of water to cities on their shores. The problem of securing an adequate supply of pure water for drinking, as well as a supply for fire protection, street sprinkling and industrial uses, is one of the greatest that cities have to solve. Duluth, Milwaukee, Chicago, Detroit, Cleveland and Buffalo are examples of cities that obtain their water supplies from lakes.

The supply of food fish furnished by the lakes is an item of some importance. Our Great Lakes are especially important in this way. Upon the Caspian Sea the fishing industry is carried on extensively.

In the colder parts of the temperate zone lakes furnish much ice. The introduction of artificial ice-plants has, of course, reduced the annual harvest from lakes, but in the aggregate they yet furnish a large supply. Not only do large companies harvest natural ice, but countless farmers and dairymen fill their private ice-houses with a supply for summer use.

A few lakes are important because of the salt that they supply. There are several hundred millions of tons in Great Salt Lake, and a large amount of salt is harvested annually. The Caspian Sea is another inland body of water from which much salt is obtained.

STUDIES

Compare the distribution of lakes in the United States with the former distribution of glaciers. Under what conditions would Great Salt Lake become a body of fresh water? Show that the expansion of water on freezing is of vital importance to life. Are the lakes of equatorial Africa likely to be of great importance in the future? Select some lake in your state, and write a paper on its origin and uses.

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CHAPTER XIII

GLACIERS

General Statement.—How feathery the delicate snowflakes appear as they slowly settle through the atmosphere and spread a mantle of white over the surface of the earth! Viewed through a microscope, each flake is observed to be hexagonal in form, although the variations within the hexagons are numerous. Quite different is the character of snow that has remained upon the ground for several weeks. As a result of surface melting and refreezing, as well as of compression, the snow has become quite granular, the granules or pellets being very ice-like.

Snowfields that endure for many years or centuries gradually become consolidated into ice, and slowly move from higher to lower levels. These moving masses of snow and ice, together with whatever they transport, are termed *glaciers*. To the fields of granular snow which serve as the sources of glaciers the term *nevé* is applied.

Distribution of Glaciers.—The fertile plains in the central part of the United States as far south as the junction of the Ohio and the Missouri Rivers with the Mississippi have been at different times covered by a vast ice-sheet or glacier, which originated in the Hudson Bay region. Much of western Europe, including practically the entire area of the British Isles, has several times been ice covered. This shows clearly that these parts of the earth have undergone great changes in climate. The time involved represents thousands of years, however.

No one can state positively the cause or causes of the ice periods. The conditions, whatever they may have been, were such as to produce lower temperatures than now exist in the formerly glaciated areas. Increased altitude, a variation in the inclination of the earth's axis, a decrease in the percentage of water vapor and carbon dioxide gas, and a change in the position of ocean currents, are all given as possible causes.

At the present time permanent snow-fields are found only in the frigid zone and upon lofty mountains in the other zones. The line above which snow remains upon the ground permanently, the *snow line*, varies in altitude from about 18,000 feet in equatorial regions to sea level in polar areas. The altitude of this line depends chiefly

FIG. 43.—Map of United States showing glaciated area.

upon temperature and amount of precipitation. It is higher on the north slope of the Himalaya Mountains than it is on the south slope, because the amount of snowfall is greater on the south than on the north. Although glaciers cannot *originate* below the snow line, they extend below it.

The greatest snow-field in the world surrounds the South Pole and is known as the Antarctic Ice Cap. In the Arctic regions there is another extensive snow-field. Practically the entire area of Greenland (about 800,000 square miles) is glacier-covered. Smaller but

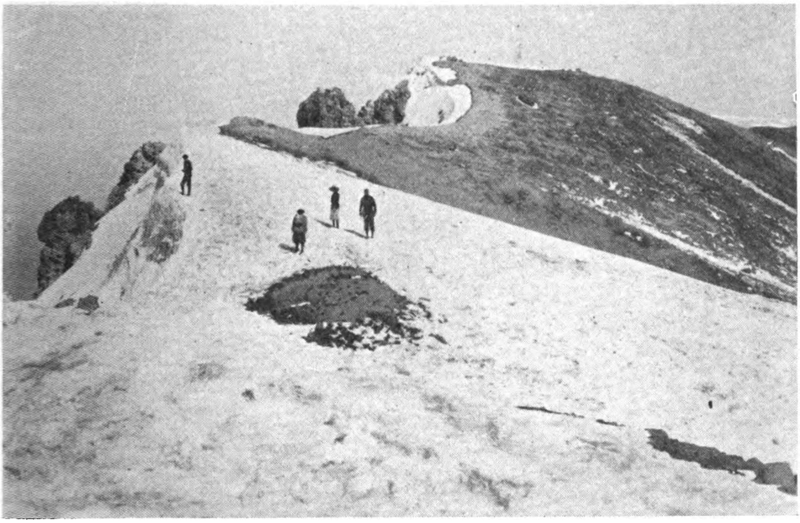

Photo by B. W. Griffith.

FIG. 47.—A glacier, summit of Mt. Hood.

very extensive glaciers exist in Alaska, several of which are 50 miles or more in length. In the Alps there are some 2,000 glaciers, and in the Caucasus, Himalaya, Andes, Sierra Nevada, Cascade, Rocky and other lofty mountains there are many small *valley* glaciers.

Movement of Glaciers.—Agassiz devoted much time to the study of the causes, the rate and the nature of glacier movement. By driving a row of stakes into the surface of a glacier and fixing their position with reference to some stationary point on land on either side of the glacier, movement, the rate of movement and the fact that the central part moves more rapidly than the sides can be demonstrated.

The movement is in all cases slow. Probably the average is not more than one foot per day. On steep slopes gravity is an important cause of movement, but some glaciers are situated upon areas that have very little slope. In all cases melting and refreezing, with the consequent expansion and contraction, may be regarded as a primary cause of movement.

Ice, when placed under sufficient pressure, can be made to assume practically any form, which suggests that ice under this condition is not a solid. The movement of glacier-ice is not, however, like the movement of liquids, but more like that of viscous bodies, such as

Photo by B. W. Griffith.

FIG. 48.—Crevasse on Elliott Glacier, north side of Mt. Hood.

asphalt. A glacier adapts itself to the irregularities of its channel, and to this extent its movement is like that of a stream. Owing to the stress placed upon it, the ice develops many fissures in its movement. In this respect a glacier is quite unlike a stream.

Characteristics of Glaciers.—Viewed from a distance a glacier generally presents a dazzling white appearance, and seems to have very little relief. Closer acquaintance shows that (in case of most glaciers) there are boulders and dirt upon the surface, and that in places the surface is so broken by cracks, pinnacles and well-like depressions as to make travel very difficult and sometimes impossible.

During the warmer hours of a summer day water flows in countless rills over the surface of the ice. It cascades over ice precipices, and drops into the yawning cracks or *crevasses* in the ice. The crevasses are most numerous where the surface over which the glacier moves is roughest. They are the result of the strains to which the ice is subjected as the glacier moves along its course. Within the crevasses the blue tints of the ice are most beautiful.

As rock warms rapidly, the small stones and the dust upon the surface of the ice become quite warm during a summer day. They melt the ice beneath them, and consequently settle into the depressions thus formed. This process is repeated from day to day, giving rise to what are known as "dust wells." Drinking at these wells is one of the pleasures of exploring glaciers. Large pieces of rock do not have time to become heated to their lower surfaces. They therefore protect the ice beneath. As melting on the surface not so protected is greater, the boulder-covered ice in time stands in the form of pinnacles.

In describing the glaciers of Spitzbergen, Lord Dufferin says: "A forest of their lilac peaks, so faint, so pale, that had it not been for the gem-like distinctness of their outline one could have deemed them as unsubstantial as the spires of Fairyland."

Streams of water issue from beneath glaciers which terminate upon land. Sometimes, as in the case of the Bossons Glacier in France, and the Great Glacier of the Illicillewaet in British Columbia, the streams issue from ice-caves of considerable size. One may enter these caves and thus see the conditions that exist in and under glaciers.

The front of a glacier, the *ice foot*, may be very steep and high, or the slope may be very gentle. By means of an ice-pick one can cut steps in the ice, and thus ascend a steep slope. Travel over the surface of the ice is greatly facilitated by the use of ice-picks. Woolen stockings drawn over one's shoes prevent slipping.

Where glaciers end in the sea, the ice, as it moves forward, is buoyed up by the water and breaks up into icebergs. The icebergs float out to sea, and are a great menace to vessels. Only about one-eighth part of an iceberg is above water. The mass of a berg projecting 50 feet above the water may therefore be very great. The *Titanic* disaster was caused by collision with an iceberg. Icebergs chill the atmosphere which comes in contact with them, thus causing fogs. As large numbers of icebergs float over the Grand Banks, this is a very foggy part of the ocean. Numerous fishing boats frequent this region, and accidents are frequent.

Results of Glacier Movement.—In consequence of the movement of glaciers there is friction between the ice and the rock with which the glacier is in contact. As the ice is in some cases hundreds of feet in thickness, the friction at the bottom of the glacier is enormous. Rocks are torn from the sides of the valley, and are carried forward by the ice, or are pushed before it. Some of the material which falls upon the surface of the glacier finds its way down into the crevasses. Thus it happens that material is pushed in front of the ice, and carried upon and within the ice. The boulders which are imbedded within the ice polish the rock over which the glacier passes, and often leave parallel scratches called *striæ* upon the rock.

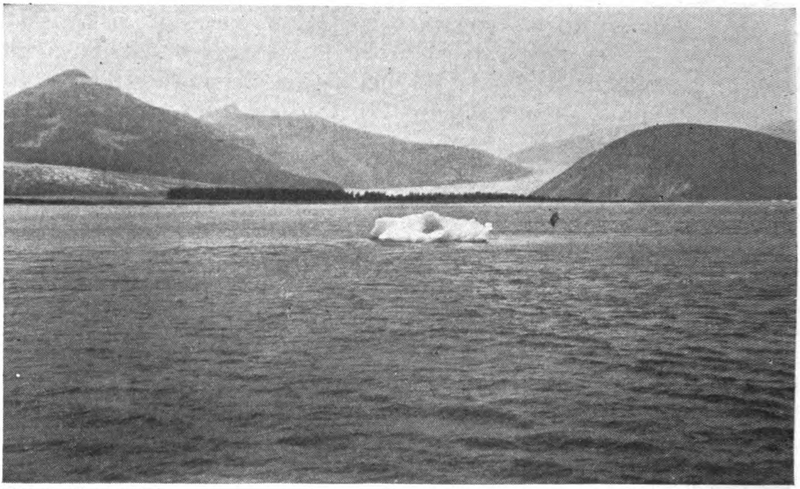

Photo by Chamberlain.

Fig. 49.—An iceberg. Note the glacier in the distance.

The law governing the transportive power of streams does not apply to glaciers. Hence materials of all sizes are transported side by side and at the same rate. They are dropped in the same unassorted condition when the ice melts. As water-borne material is assorted, the presence of a mantle of unassorted waste is strongly suggestive of the former presence of glaciers in the area.

Glaciers widen and deepen valleys. The fiords described on page 158 have been acted upon by ice, as has the Yosemite and many other similar valleys. Rock basins are enlarged, and perhaps in some cases formed, by glacial erosion.

Glacial Deposits.—Streams deposit material at one time which may at another be picked up and carried a considerable distance.

The same is true of glaciers. The load of the glacier is finally thrown down where the ice melts, that is, at the termination of the glacier, unless the glacier ends in a body of water. The material which accumulates at the foot of the glacier is known as a *terminal moraine.* If the ice front remains practically stationary for a long term of years the terminal moraine will be in the form of a ridge. The position of the ice front varies somewhat from season to season and from year to year.

When a glacier finally retreats from an area the surface of the land is covered with boulders, gravel and fine material. This is called *glacial drift.* Fig. 46 shows the extent of the drift-covered area in North America.

Influence of Glaciers Upon Life.—Perhaps the greatest influence of glaciers upon human life is found in their relations to agriculture. In our North Central States the drift is in some places many feet in thickness. A great work was done here by way of preparing the soil for the use of man, for the rock was relatively easily eroded. The pulverized condition of the soil, as well as its depth, has made available much material for plant use. The decreased relief of the land due to glaciation favors the use of farm machinery. The value of land in glaciated countries is, as a rule, much greater than that in non-glaciated countries, where other conditions are very similar. In New England the drift is more largely in the form of boulders. These are a detriment to agriculture. For generations the farmers have piled them up and built them into walls and the foundations of houses and barns.

As the ice moved over the land much material was deposited in stream valleys. The blocking of streams led to the formation of rapids and falls, and in some cases to a change in the course of the streams. In New England many falls originated in this way. These now furnish power and light, and were very instrumental in giving to New England in early days her supremacy as a manufacturing district.

Great numbers of lakes in North America and in Europe have resulted from glacial dams thrown across streams. These are valuable from many points of view. Some furnish a water supply. In most of them there are fish of some value. Those that are of considerable size influence the climate of their leeward shores. They furnish situations for resorts, and are thus of value to many classes of people. In the colder parts of the world, ice is harvested upon them during the winter.

As the general effect of glacier deposition is to reduce the relief, a result of glaciation is to make the construction of roads easier than it would otherwise have been. This is illustrated in the central part of the United States, in the adjacent parts of Canada and in western Europe.

Gravel taken from moraines is used upon roads and in the manufacture of cement. Brick, tile and pottery are extensively manufac-

Photo by Chamberlain.

FIG. 50.—A moraine on Mt. Shasta.

tured from "rock flour." The valley of the Hudson and the region about Chicago illustrate this use of a natural resource.

Glaciers as features of scenic interest attract people in large numbers, and therefore have an important economic relation to man. They also have a value which cannot be measured in this way. Switzerland has for a long time derived large sums of money annually from tourists, and the glaciers are one of the attractions of Switzerland. More recently Alaska has been claiming attention as a pleasure resort. Many of her glaciers can be seen from the decks of the excursion steamers. Some of the glaciers in the Selkirk Mountains in British Columbia are very beautiful, and quite accessible. The foot of the great glacier of the Illicillewaet is but 45 minutes' walk from the station at Glacier. One of the great attractions of Glacier National Park is the large number of glaciers and glacier lakes.

We are now in a position to appreciate what Shelley says concerning glaciers:

"The glaciers creep,
Like snakes that watch their prey, from their far fountains,
Slowly rolling on; there many a precipice
Frost and the Sun in scorn of mortal power
Have piled—dome, pyramid and pinnacle,
A city of death, distinct with many a tower
And wall impregnable of beaming ice;
Yet not a city, but a flood of ruin
Is there, that from the boundaries of the sky
Rolls its perpetual stream; vast pines are strewing
Its destined path, or in the mangled soil
Branchless and shattered stand; the rocks, drawn down
From yon remote waste, have overthrown
The tenants of the dead and living world,
Never to be reclaimed."[1]

STUDIES

On a map of the world locate the great permanent snow-fields. Explain their distribution. How is the former extent of the ice-sheet in the United States known? Why is there so much difference between the surface features of different glaciers and between the different parts of the surface of the same glacier? Do streams issue from beneath *all* glaciers? Write a paper showing how glaciers have influenced human life in some particular locality. On a base map of the United States chart from memory the former and the present distribution of glaciers. The results of glacier action are a detriment to the farmers of New England, but the farmers of the Middle West profit because of the results of ice action in that area. Explain.

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[1] Shelley: "Mont Blanc."

CHAPTER XIV

THE SOIL

General Statement.—The soil is the most important of all natural resources, for upon it, either directly or indirectly, all life depends. Popularly the term *soil* refers to the loose material that mantles the solid rock of the earth. Soil varies as to composition, texture, color, depth and fertility.

Origin of Soils.—Soil is chiefly ground-up rock. Imagine the soil to be removed from a given area so that a bare rock surface is exposed. The heat of the day expands the rock slightly, while the low temperature of the night causes a slight contraction. Thus little by little the surface of the rock is chipped and shattered. Into the tiny openings, found in all rock, water penetrates, and when it freezes it exerts a powerful pressure, often sufficient to rend masses of considerable size. Upon the surface of the rock lichens, plants which have no true roots, obtaining their nourishment from the air, establish themselves. These slowly form soil, both by aiding rock disintegration and through their own decay. In time larger plants and even trees establish themselves upon the rock. They extend their roots into the crevices and cracks, exerting a tremendous force, adequate at times to pry off great slabs many feet in length. The openings, enlarged by the roots, offer still greater opportunity for the penetration of water.

Each piece of rock broken from a larger mass is acted upon by the weather and by plants still more rapidly than it was before being detached, because of the increased area exposed. It is finally reduced to the condition of soil.

Every stream is one of Nature's mills in which rock is being slowly but constantly ground. As we go down stream we observe a larger and larger proportion of fine material because the rock has been in the mill for a longer time than has that in the upper part of the stream, and has been transported a greater distance. When the stream finally reaches the body of water into which it empties, it deposits first the coarser materials—gravel and sand—and later, that is, farther out, the clayey material is laid down. Along every sea and lake shore the waves are battering down the cliffs, rolling the rocks and pebbles back and forth along the beach, and thus gradually reducing them to fine material.

Glaciers, in their slow march down mountain slopes and across plains, exert an almost irresistible force upon the surfaces over which they pass. They tear boulders from the mountains; they drag them over the rock, breaking the corners, wearing them down, and reducing some of them to a powder called "rock flour" or "glacier flour."

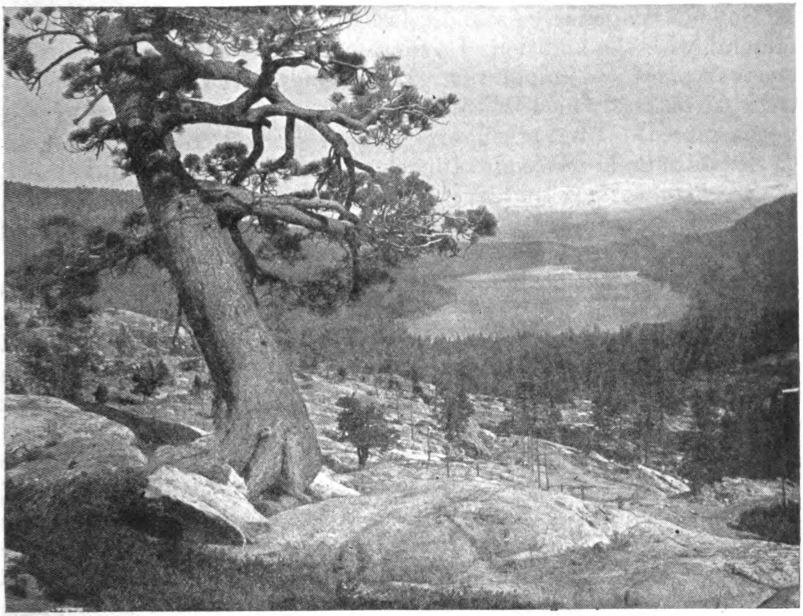

Photo by W. G. Scott.

FIG. 51.—Roots of tree breaking rock.

Even the winds do their part in the soil-making process, for they hurl sand grains against the rocks and so erode them into most fantastic forms. Their work is, of course, most important in arid regions.

Burrowing animals, such as rabbits, squirrels, gophers, and even earthworms, bring to the surface subsoil and bits of rock which are still further acted upon by the atmosphere. Darwin found that in parts of England more than ten tons of earth on each acre annually pass through the bodies of earthworms. This work does much to prepare the soil for the use of plants. "The plough is one of the most ancient and most valuable of man's inventions; but long before he existed the land was in fact regularly ploughed, and still continues to be thus ploughed by earthworms. It may be doubted whether there are many other animals which have played so important a part in the history of the world as these lowly organized creatures."[1]

Thus streams, waves, glaciers, winds, changes in temperature, surface and ground water, plants and animals are steadily working, creating soil from the rocks of the earth's crust. Without the work of these agents life would not be possible upon the earth.

Soil is, then, chiefly ground-up rock, sometimes 95 per cent. being mineral, with the addition of some organic matter derived from the decay of plant and animal life. This organic material gives the dark color to the soil which is usually seen in the forests, meadows and boggy places.

Kinds of Soil.—Soils are often classed as sandy, loamy and clayey. A sandy soil is *light*, that is, it is easily cultivated. A clayey soil is called *heavy* because it is not easily worked. When a soil contains considerable vegetable mould it is called *loamy*.

A clayey soil, being composed of fine particles, generally contains much plant food, and being close in texture holds water. Hence clayey soils are usually productive or *strong*. They also withstand drought well. A sandy soil, being composed of the larger particles and not a good retainer of water, is generally less productive, and not well adapted to conditions of drought.

A soil formed by the decay of the rock underlying it is often called a *residual* soil, meaning that the soil is that part of the decayed rock that was not washed away. Soil that did not originate in the place where it is found is called *transported* soil. Soils are transported by rivers, glaciers and winds. *Drift* is a term commonly applied to glacier transported soils, *alluvial* to soils deposited by running water, and *eolian* to soils deposited by the winds. The deltas of the Mississippi, the Colorado, the Po, the Ganges, the Hoang-ho, the Nile, and others, are composed of alluvial soils. In these, and other cases, the soil is fertilized each year by floods.

Natural Fertility.—There is much variation in the fertility of soils. Some, like those of the deltas of the rivers mentioned above, are practically inexhaustible, because with the annual flooding of the rivers, sediments are brought down and deposited. The limestone soils of the blue-grass region of Kentucky are noted for their fertility. Ages ago, when the waves of the sea rolled over this region, minute forms of marine life extracted from the water carbonate of lime, and built it into their bodies. In time the limy portions

[1] Darwin: "Formation of Vegetable Mould," p. 91.

of these and other larger creatures collected on the sea floor and were converted into limestone. Elevation brought this part of the sea bottom above the water. The slow process of decay already outlined converted some of this limestone into soil, which nourishes vegetation for the use of man and beast. Thus is represented an interesting cycle from ocean water to human life. In Alabama, Mississippi, Louisiana and Texas there is a belt of fertile limestone soils. This is the great cotton belt of the South.

In the eastern part of Kentucky and Tennessee the underlying rock is sandstone, the decay of which contributes little plant food to the resulting soil. In this section agriculture does not flourish, and the population is sparse. It must not be inferred from this that all sandstone soils are infertile. Soils resulting from the decay of silicious sandstones are infertile, and sandstones always produce light soils.

The soil of New England was, even in Colonial times, considered infertile. It was said "not even a hill of corn can be grown unless a fish be placed in it." Here the resistant granite rock has weathered slowly. Even the glacier did not grind it up as it did the less resistant limestone of the Mississippi valley. The coarseness of the material is not without its advantage, however, for the slow decay of the pebbles, boulders and rock masses contributes the elements needed by plant life. Thus the cultivation of this soil tends to increase its fertility, for it furthers the process of rock disintegration, liberating the potash, soda, lime and phosphorus. Granite soils are usually rich in potash.

Glacial soil, which is fine in texture, is very fertile. "The fineness of the glacier flour renders it peculiarly suitable for the rapid conversion into soil, and such soils are usually excellent and remarkably durable. The great and lasting fertility of the soils of southern Sweden is traced directly to this mode of origin, and doubtless the great American ice sheet of glacier times is similarly concerned in the high quality of the soil of our north central states, from the Ohio to the Great Lakes and the Missouri."[2] When a lake disappears its floor generally is found to be very fertile soil, for upon it were deposited, at least at some distance from shore, the fine materials held in suspension by the stream or streams that flowed into the lake. The former floor of the now extinct Lake Agassiz is one of the richest wheat-growing districts in the world.

The soil in arid regions is usually non-productive because of lack of rainfall, and not because of lack of fertility. There are sections,

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[2] Hilgard: "Soils," p. 5.

however, where, owing to alkali, the soil cannot be used for general agriculture until the alkali has been washed away or partially exhausted by the growing of plants, such as the sugar beet, tolerant of alkali.

The extent and the fertility of the soil exert a marked effect upon the economic geography of the world. The great food-producing areas are those having a fertile soil, and some of these support a very dense population. The delta lands of China and India are excellent examples.

"The Great Plain of the Hoang-ho delta, partly surrounding the mountainous Shan-tung peninsula, and the great delta of the Yangtze, make up the only large plain areas in China. Though large in themselves (their combined areas being equivalent to the states of Ohio, Indiana, Illinois and Kentucky) these plains occupy scarcely one-eighth of China's surface. They support, however, fully forty per cent. of China's vast population, and furnish in addition a large proportion of her exported crops."[3] The "Black Earth" region in Russia supports a large population. The productiveness of our North Central States is remarkable. As has been said, this is thought to be due to the glacier flour deposited by the ice sheet that formerly covered the region. The fertility of the soil of these states is to no small extent responsible for a tremendous lake and land commerce, and for the development of the region generally.

STUDIES

Was there a period when there was no soil upon the earth? Explain the formation of soil. What is the nature of the soil in your locality? Is it residual or transported? What is its average depth? Why do soils become exhausted? Compare sandstone and limestone soils as to fertility. How can the loss of soil as a result of stream action be checked?

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[3] Roorbach, G. B.: *Journal of Geography*, vol. xi, p. 47.

CHAPTER XV

THE OCEAN

The Coast Line.—The margin of the sea is a zone of great activity on the part of both Nature and man. Here the tremendous energy of the waves is expended in battering down even the most

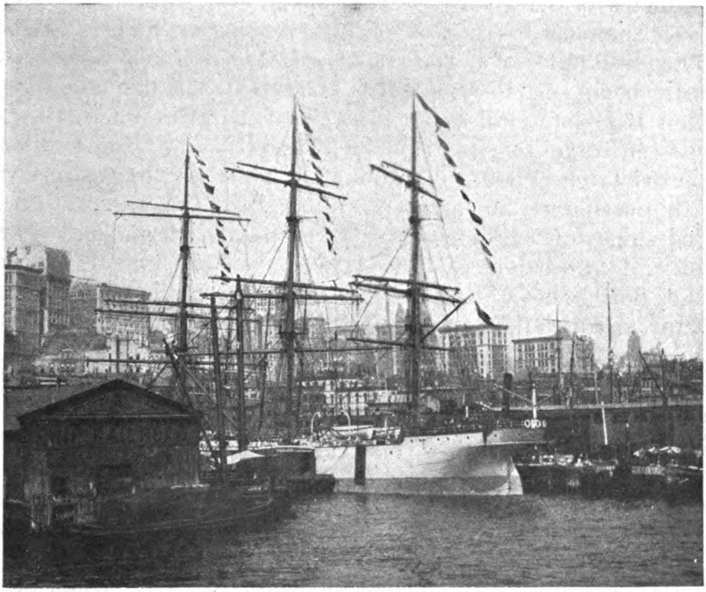

FIG. 52.—A seaport.

resistant cliffs, and here stream, wave and shore current spread out upon the continental shelf vast quantities of sediment.

Along the margin of the sea countless ships daily unload commodities and people brought from distant shores, only to be reloaded with freight and passengers bound for other ports. Most of the great cities of the world are situated on or near the margin of the sea.

There are few countries that possess no coast line. Paraguay, Bolivia, Switzerland and Serbia are striking exceptions. The craving on the part of nations for frontage upon the sea is as great as that of individuals for frontage upon the streets of the cities.

The character of the line formed by the meeting of the land and the sea plays an important part in promoting or retarding the development of an area. An irregular coast line offers, as a rule, great advantages for the establishment of seaports, and consequently for the easy exchange of commodities, for the growth of industry and commerce, and for the spread of all that comes under the broad title of culture. A regular coast line is generally deficient in good harbors; hence an extensive sea commerce can only be developed at great cost.

Examples of Irregular Coasts.—Of all the continents Europe possesses the most irregular coast line, having one mile of coast line to 150 square miles of her area. North America is a close second, her ratio being one to about 164. Germany has one mile of coast to about 160 square miles, but in Norway the ratio is 1 to 10.

One can travel by ship from Seattle northward for a distance of approximately 1,000 miles, and during almost the entire voyage be within a channel but a few miles in width. On the east are the wooded slopes of the mountains of the mainland, and on the west innumerable timbered islands. The winding channel constantly discloses new scenes of beauty as the ship forges ahead.

Many small valleys, the seaward parts of which have a great depth of water, are tributary to the channel. These inlets are relatively narrow and have steep sides, sometimes rising to a considerable distance above the water. Inlets of this character are termed *fiords*. Southern Chile, Scotland, Norway, New Zealand and Maine present other illustrations of fiorded coast lines.

Influence of Irregular Coasts.—It was long ago pointed out by Guyot that there is some relation between the extent of coast possessed by an area and the development of that area. Europe is the most highly developed of the continents, and, as has been stated, it has the most irregular coast. Not all areas having irregular coast lines are highly developed, however.

In the case of Europe the land and the water are in contact at so many points that no part of the continent is very far from the ocean. This contact with the sea did much to foster the fishing industry and to promote discovery, and today it is of vast commercial importance. In yet another important way Europe benefits by her irregularity of coast. The climate is more equable than it would be were the coast line regular.

No point in the British Isles is more than 100 miles from the sea. The great importance of this is evident. The cost of getting the exports to the sea is reduced to the minimum, and the expense of

FIG. 53.—An irregular coast.

shipping the imports from one point in the islands to any other is correspondingly small. In these islands alone we have the well-known seaports of Queenstown, Dublin, Belfast, Glasgow, Edinburgh, Newcastle, Hull, London, Dover, Southampton, Bristol, Liverpool, and others. This condition gives the British Isles an advantage over Germany, some of whose cities are 400 miles from the sea.

As both lumbering and fishing are important in Norway, her irregular coast is of great value in these industries. Most of the people live close to the sea, the towns and cities being situated upon the fiords. The nature of the coast is such that a road connecting two points along the sea is likely to be several times as long as a water route connecting the two. On this account, travel by row-boats is more common than travel by means of wheeled vehicles.

Southern Alaska does not profit as much by her irregularity of coast line as does Norway. This is in part because the back country, owing to severity of climate, is not productive, and in part because civilization is young. As in Norway, however, there are fishing villages on the fiords, and these furnish the connecting link between the interior of Alaska and the outside world. The beauty of the fiord coast is yearly attracting a larger number of tourists to Alaska, just as the better known fiords of Norway have for a long time drawn visitors to her shores. A fiord coast necessitates a large number of lights, the maintenance of which is a considerable financial burden. Along the coast of southern Alaska there are many lights which burn continuously for a period of six months. Along irregular coasts that are well supplied with seaports, there are many life-saving stations.

Examples of Regular Coasts.—The regularity of the coast of Africa is remarkable. No other continent possesses such a limited extent of coast line in proportion to area. Nowhere do bays penetrate the land deeply; nowhere do projections extend far into the sea. The lack of good harbors is proverbial. Arabia and India present great regularity of coast. The coast of Peru is very deficient in harbors. California stretches from the latitude of Boston to that of Charleston, South Carolina, yet has very few good harbors.

Influence of Regular Coasts.—The St. Lawrence, the Hudson and the Mississippi are natural gateways leading into North America. By means of the Orinoco, the Amazon and the Parana, explorers reached the interior of South America. In the whole coast of Africa no such gateways exist. This is one reason for the tardy develop-

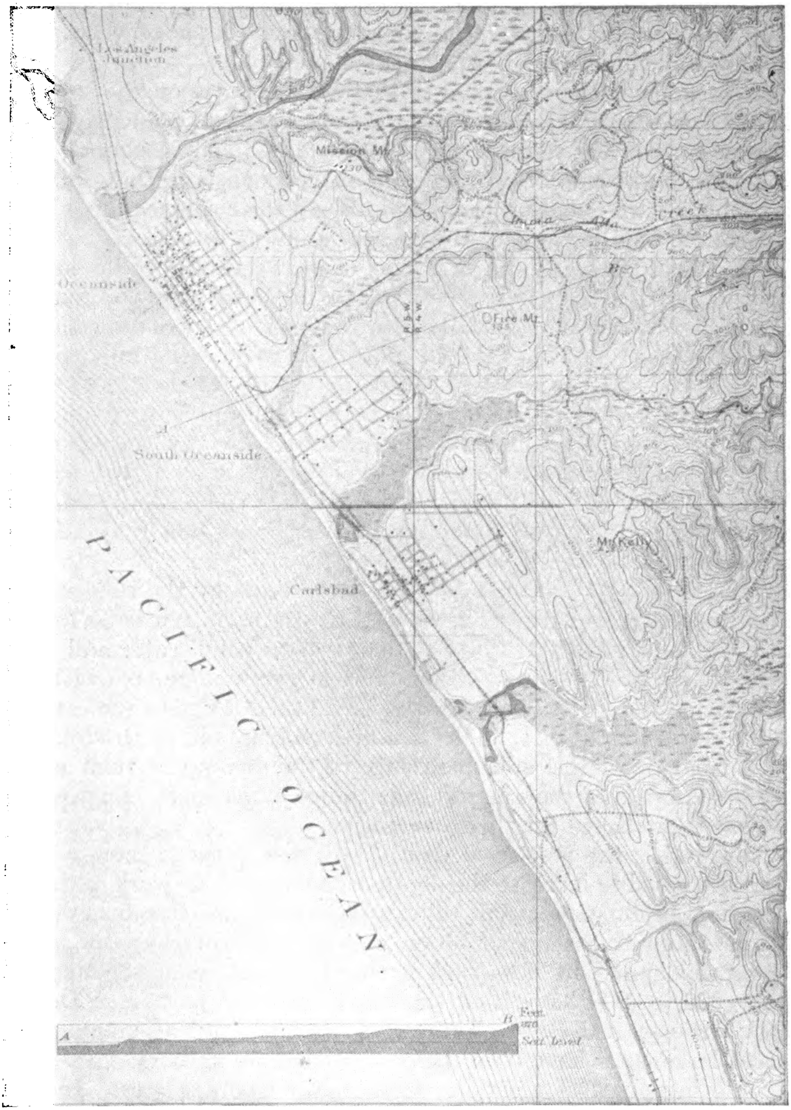

FIG. 54.—A regular coast. Ocean side, California. (U. S. Geol. Survey.)

ment of the continent. Australia's coast line is broken by but one river of considerable size (the Murray), and this is of very little commercial importance.

So regular is the coast and so shallow the water on the seaward side of Texas that Galveston was established upon an island of sand—a position in other respects very unfavorable. The coasts of Peru and northern Chile are so deficient in good harbors that ships in some places are obliged to load and unload their cargoes by means of lighters. Mollendo and Antofagasta are illustrations.

Depths of Harbors.—In these days of great ocean liners the importance of seaports depends, in very large measure, upon the number of feet of water in their harbors. In the early history of our country, Salem, Massachusetts, exceeded Boston in commercial importance, but as ships of greater draught were built, the commerce of Salem declined in favor of that of Boston, where deeper water existed.

In order to accommodate the greatest ocean-going vessels a harbor must have more than 40 feet of water. New York, Boston, San Francisco, Rio de Janerio, London, Liverpool, Southampton, Queenstown, Le Havre, Hamburg, Antwerp and Sidney are among the deep harbors of the world.

The value of a harbor is in part determined by the tidal range. If, for example, the depth of water in a certain harbor is 35 feet at high tide and 25 feet at low tide, many ships could enter and clear at high tide which otherwise could not carry on commerce with the port unless they employed lighters. The tidal range in the estuary of the Severn is 40 feet. This is a great advantage to Bristol.

A tidal time-table and knowledge of the amount of tidal range in every port is of the greatest importance to mariners. Such information is published for their benefit.

So vital is the matter of depth that vast sums of money have been expended to increase the depth of harbors. The work of dredging must be repeated from time to time, because streams, waves, currents and tides deposit much material in some harbors. The Ambrose Channel in New York harbor has cost about $6,000,000. Some $20,000,000 have been expended upon the harbor at Dover. At Cherbourg and Brest, France, at Antwerp, and at many other places large sums have been spent for deepening harbors.

Another point of great importance in harbors is area. In this respect Rio de Janerio, Sydney, New York, and San Francisco are noteworthy. Where space is limited, breakwaters are sometimes constructed, inside of which ships find safe anchorage.

Protection to Shipping.—Much of the money that goes into harbor improvement is used for the protection of shipping. Sea walls are constructed, light-houses, buoys, bells, and a life-saving service established; forts are built and submarine mines planted.

Climate as Related to the Value of a Coast Line.—A country may have a great extent of coast line and yet not derive much benefit from it because of a short open season. Russia furnishes an excellent illustration. Along her whole northern coast there is not a harbor that is naturally free from ice during the entire winter. Alexandrosk

FIG. 55.—Work of waves, La Jolla, Calif.

and Kola are open most of the time, however. The same is true of the harbors on the Baltic. Even at Vladivostok the harbor would be closed for a part of the year were it not for the fact that ice-breakers are employed.

The northern ports of Germany suffer from the same cause, but not to the same extent, although ice-breakers are employed at Stettin. Owing to the fact that the St. Lawrence is ice-bound for several months each year, a considerable portion of Canada's commerce is during this period deflected to Halifax, Nova Scotia, and Portland, Maine.

Influences Shaping Coast Line.—One who has witnessed the waves beating upon a shore must have realized that they have much to do with shaping coast lines. On the western coast of the British Isles waves have been known to strike with a force of three tons to the square foot, and the average winter force on that coast is about one ton per square foot.

It is evident that, as a result of their repeated attacks, waves can cause to crumble even the most resistant rocks. Waves, like running water, use rocks, pebbles and sand grains as their tools. Projections are cut away and indentations filled with sediment. Thus the ultimate effect of wave erosion is to make a coast line more regular.

FIG. 56.—Wave-cut terraces on the California coast. U. S. Geol. Survey.

The rate at which a shore line is eaten back is often increased by under-cutting, which causes overhanging rock masses to fall. Where rocks are tilted, the irregularities due to erosion are likely to be greater than where the rocks are horizontal.

The constructive work of streams is of some importance in changing shore lines, hence in a local way in changing economic conditions. The city of Adria, as stated elsewhere, was once a port on the Adriatic Sea, but it is now 14 miles inland. The Rhône is advancing its delta at the rate of 200 feet per year. The northern coast of the Gulf of Mexico was once far north of its present location.

Diastrophic movements (page 139) leave unmistakable evidences along shore lines. Subsidence along a continental shelf pushes the coast line landward. The valleys are depressed below the level of the sea, are filled with water, and are therefore said to be *drowned.* The hills and ridges that are not submerged form capes, peninsulas and islands.

The land is acted upon by many agents of erosion, but the sea floor is protected by the water. Therefore a land surface is more irregular than the sea floor. After subsidence the new shore line which is located upon a former land area is more irregular than it was before the subsidence occurred. We have, then, this general law: *subsidence of a continental shelf increases the irregularity of the coast line resulting from such subsidence.*

The wonderfully beautiful coasts of Norway and southern Alaska owe their character in large part to a drowning of the regions. In both cases glaciers have played a part in deepening and widening the fiords. A sinking of the land gave to eastern North America north of New Jersey a very irregular coast. What was before this event the seaward portion of the Hudson valley now exists as a submerged canyon, which has been traced along the present continental shelf for more than 100 miles. It was the drowning of the Hudson valley which produced the splendid harbor upon which New York City is situated, and a waterway having a minimum depth of 11 feet as far north as Albany. The St. Lawrence valley was drowned for a distance of 200 miles inland from its present mouth. This made Quebec in effect a seaport.

When as a result of elevation a continental shelf, or part of it, is raised above the level of the sea, the resulting coast line is established upon the former sea floor. As has been said, the sea floor is little influenced by the agents of erosion; moreover, the streams are bringing to it the waste of the land, which tends to obliterate irregularities. Consequently the new shore line will be more regular than the old. *Elevation of continental shelves increases the regularity of coast lines.*

Not infrequently, along a coast that has been uplifted, the terraces cut by wave action as the water stood at successive levels remain as proof of the elevation. At many points along the coast such terraces may be seen.

The coral polyp plays its part in fashioning shore lines. The Florida Keys are of coral formation, and these have made possible the construction of a railroad connecting Key West with the mainland. The Barrier Reef, off the eastern coast of Australia, is about 1,000 miles in length, and averages about 30 miles from the mainland. It protects the channel between it and the continent, and is thus of considerable importance to commerce.

The Ocean Basin.—The ocean covers about three-fourths of the earth's surface, the average depth of the water being about 2½ miles, and the greatest known depth about 30,000 feet. Although the depth of the ocean is very great, it is slight in proportion to its width. The topography of the ocean floor is much less varied than is that of the land. This is due to the absence of agents of erosion, and to constant deposition of sediments upon the floor.

Temperature of the Ocean.—As water heats and cools slowly, the great volume of the ocean causes it to have a marked effect upon the temperature of the lands, especially the coastal areas toward which the winds blow. Summers are cooler and winters warmer than they would be were the volume of the ocean less than it is.

The fact that the heat of the sun is applied to the surface of the water is an important reason why the temperature at considerable depths is always low. The decrease in temperature with increase in depth is not uniform, being most rapid near the surface. On the floor of the deepest parts of the ocean in all latitudes the temperature is below 32° F., yet the water is not frozen. This is due to its salinity and the great pressure.

Light.—Except for phosphorescent light, the depths of the ocean are in constant darkness. In fact, sunlight penetrates but a short distance below the surface. Many of the animals at great depths are eyeless, but others are supplied with the organs of sight.

Pressure.—At sea level, as already explained, the average pressure of the atmosphere is 14.7 pounds per square inch. Pressure increases at the rate of about three atmospheres for each 100 feet of descent. This means that one mile below the surface of the ocean the pressure is about one ton per square inch.

Life.—The uniformly low temperature conditions, the absence of light, and the enormous pressure are all unfavorable to the development of life forms of a high order of intelligence. The life is most abundant relatively near shore, for there the food washed in from the lands is most plentiful, and temperature conditions are most favorable. Many of the forms are of great value to man, and most of these have been treated elsewhere. Others are: lobsters, turtles, corals, sponges and pearl oysters.

Knowledge of temperature and pressure conditions at great depths is obtained by means of self-recording instruments. Small nets lowered to considerable distances and dragged behind vessels capture some of the life forms, but naturally our knowledge of ocean life is very incomplete.

Waves.—Waves are caused by the winds, and the greater the velocity of the wind the higher the waves. Although there appears to be a transference of water this is not the case except near shore. It is the motion that is transmitted; the particles of water simply rise and fall. Proof of this can be obtained by throwing a stick out from shore and observing its movements. The importance of waves is treated elsewhere in this chapter.

Ocean Currents.—The winds cause currents as well as tides. Where the winds are most constant, namely, in the tropical zone, the currents are best developed. The direction of the currents is, of course, greatly modified by the outlines of the continents and by islands. Currents are both warm and cold, the cold currents moving from higher to lower latitudes. Owing to the fact that cold water is more dense than the warm water, much of the former is transferred equatorward below the surface water. Although ocean currents have some effect upon climate, their influence has been greatly exaggerated. The volume of our largest ocean currents is very slight as compared with that of the ocean, and it is to the latter that the moderating influence is chiefly due. Before the days of steamships the ocean currents were more important to navigators than they are today.

Tides.—In the open ocean the tides have no importance, but along the shore they are closely related to human affairs. This relationship is discussed in Chapter XXXIV.

STUDIES

How far is each of the following from a seaport: Leeds, Bradford, Manchester, Sheffield, Birmingham? What is the commercial significance of this? Why does our government spend so much money in guarding life and property on the New England coast? Make a list of our harbors which have a depth of 25 feet or more. What special advantage does Southampton, England, derive from the tides? Is Sitka, Alaska, ever ice-bound? Explain. If the floors of the ocean were uncovered, how would they appear? Is the salinity of the ocean changing? Explain. Of what advantage to man is the great extent of water surface? Can the ships that were sunk during the World War be salvaged?

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PART TWO

AGRICULTURE AND AGRICULTURAL PRODUCTS

CHAPTER XVI

THE RESPONSE OF THE SOIL

General Statement.—The fruits, berries and nuts of the forest, as well as such animals as could be captured, supplied primitive man with food. As time passed he learned to assist Nature by cultivating the soil. How early agriculture began is not known, but it has been practiced in China, Egypt, and other parts of the East for many centuries. Probably the women were the first tillers of the soil, as this custom would leave the men free to hunt and fight.

For hundreds of years it has been the custom for the ruler of China to appear before his people on a certain day each year and devote a few minutes to plowing. In Peking, China, there is an ancient and imposing building called the Temple of Agriculture. These two facts show that in China tilling the soil is regarded as an honorable occupation. Indeed it has long been regarded by the Chinese as the *most* honorable of callings.

All life depends for maintenance primarily upon the soil. This is well illustrated by the familiar expression "Mother Earth." Although our food consists of both animal and vegetable matter, animals depend directly or indirectly upon plants for their food. Causing the earth to bring forth food for man is, therefore, the basal occupation of the human race.

In all countries which are to any considerable extent inhabited, agriculture is important, but some countries are preëminently agricultural. Proper temperature conditions, a minimum of 20 inches of precipitation annually, fertile soil, and a moderately even surface are the conditions which are highly favorable. Argentine Republic, Russia, Hungary, France, Belgium, India, China, Canada, and the United States are countries in which agriculture is very extensively developed. In China, British India, Hungary and European Russia more than one-half of the total population are engaged in the pursuit of agriculture. In British India, Belgium, France and Hungary about one-half of the total area is under the plow. On the other hand, although about one-third of the people of Norway are engaged in agriculture, less than five per cent. of the area is actually tilled.

Until quite recently the idea prevailed in this country that no preparation was necessary for the work of tilling the soil. Moreover, there was a marked tendency to abandon the rural districts and move into the cities, where wages were higher and life more attractive. We now recognize that there is a science of agriculture, and that the most satisfactory results can be obtained only by those who have some knowledge of the plants to be cultivated, of soil, of climate and of the relation of each of these to the others. "The activities of our age in lines of research have reached the tillers of the soil and inspired them with ambition to know more of the principles that govern the forces of Nature with which they have to deal."[1]

One of the very interesting and hopeful changes in our educational system was the introduction of agriculture as a definite line of study. We have agricultural colleges in all parts of the country, and agriculture is taught in very many public high schools, and in some special schools of secondary grade. In addition, some of the elements of agriculture are taught in the elementary schools. Indeed, the work of the pupils in these schools has, in some sections, been responsible for study on the part of adults, and for an actual improvement in quality and quantity of the crops.

Government Aid.—Through the establishment of a Department of Agriculture our government has recognized the importance of the scientific tilling of the soil. No other government does as much as does ours along this line. Largely through its efforts, the wealth annually produced upon our farms has increased enormously during recent years. For the five-year period ending with 1916 the average value of our crops was, in round numbers, $6,800,000,000. For carrying on the work of the Department of Agriculture more than $25,000,000 was appropriated for the year ending June 30, 1918.

Soil surveys have done much to enable farmers to make the best use of their farms. Since 1900 our government has extended the soil survey over large areas, classifying them as to origin and constitution of the soil, and stating the crops to which they are best adapted. Soil maps of the areas are published, and these may be secured from the Department of Agriculture at Washington.

The Bureau of Plant Industry—a branch of the Department of

[1]Roosevelt, Theodore: Message to Congress, Dec. 8, 1904.

Agriculture—has experts in all parts of the country studying the special problems in each locality. The pests with which the farmer has to contend, and the diseases that attack his plants, are given the most painstaking attention. In addition, plants are brought from foreign lands and tried where it is believed that their cultivation will be successful. In most cases the cost of these investigations is trifling compared with the returns.

The date has been introduced into southeastern California and Arizona, and is being very successfully cultivated. Long staple cotton is being grown in the Imperial valley, California, and in the Salt River valley of Arizona. Durum wheat was brought from northern Africa and Russia and planted in our semi-arid belt east of the Rocky Mountains. Large areas which formerly were waste places now produce abundant crops of this drought-resisting wheat. Tea-growing is now a success in North Carolina. New varieties of tobacco, rice, oranges, olives, oats and many other plants have been introduced.

The Bureau of Animal Industry carries on a similar work in its field. As a result of its studies we produce more and better wool per sheep than formerly. Cattle are bred so as to yield more or richer milk, thus greatly increasing the value of the dairy output. Similarly beef, pork, and mutton have been improved. Horses are successfully bred for the purposes of developing speed or value as draft animals. The flesh- and the egg-producing qualities of poultry have been improved.

Another very important phase of the work of this bureau is the inspection of meat. Step into any butcher shop and you will see on the quarters of beef and the bodies of the sheep and hogs offered for sale, official marks testifying to the satisfactory condition of the meat. The results of the investigations of the various divisions of the Department of Agriculture are published in such form as to be available and very helpful to farmers, stock-raisers, dairymen, poultry keepers, fruit-growers and others. Many of these publications can be secured free, and in no case is the charge large.

Our Forestry Service and our Weather Bureau are other important branches of the Department of Agriculture. These are treated in other chapters.

Movement Back to the Soil.—Recently there was an evident tendency on the part of dwellers in the cities to move into the rural sections. We heard considerable of the "back-to-the-soil" movement. The results of the Fourteenth Census are disappointing in that they show an increased movement from the country to the cities. This was the inevitable consequence of war conditions. Foremost among the causes which should operate to produce a countryward movement is the great improvement in the conditions surrounding farm life. In the earlier days the isolation of those who lived on farms was a decided objection to country life.

A few years ago the farmer was obliged to drive to the post office for his mail. In many cases the distance was so great that the trip would be made only once or twice a week during the busy

FIG. 57.—A modern farm house. (U. S. D. A.)

season. Rural free delivery now gives the farmer his daily paper, and thus he keeps informed. Higher wages on the farms are making it easier to secure and retain farm labor, and the use of the graphophone is an added attraction.

Good roads have enabled the farmer to market his produce at a greater profit than heretofore. In addition, improved road conditions have made it possible to use automobiles, have placed the advantages of the town within easy reach, and have done much to reduce the isolation and monotony of life upon the farm.

The telephone is now in use in countless farmhouses, and gas and electricity in many. The improvement in schools and the large number of farmers' societies play their part in holding the rural population. The freedom from the noises, the dust, the anxiety and the physical and moral dangers of the city, and the realization of the importance of the purer air of the country, are other factors tending to bring about a better balance between the distribution of rural and urban population.

Fertilizing the Soil.—The necessity for fertilizing the soil has been recognized for centuries. The early settlers in this country found that the Indians not only practiced agriculture in a crude way, but fertilized the soil as well. Since it was discovered that artificial fertilizers could be employed, the nations of western Europe, as well as our own, have spent large sums of money annually for them.

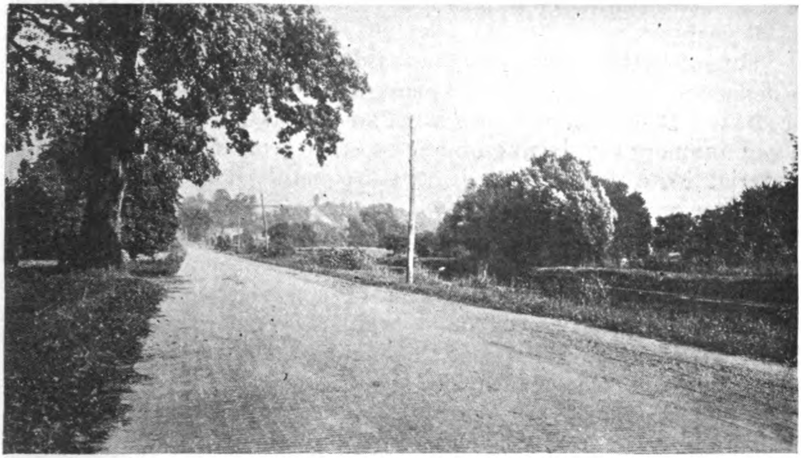

FIG. 58.—A good rural road in Ohio. (U. S. D. A.)

There are three essential elements of the soil: potash, phosphorus and nitrogen. Germany has practically controlled the potash supply of the world. Following the opening of the European War in 1914, the price advanced, and we had difficulty in securing an adequate supply of this material.

Large deposits of potash exist in southeastern California and in Utah, and the seaweed known as kelp along our western coast is rich in potash. Experimentation is being carried on in these fields, and in the near future they may meet our needs along this line.

Although about 3 per cent. of the crust of the earth is potash, only about 1-10 of 1 per cent. is phosphorus. The chief supplies of phosphorus now known are located in the United States. For years Florida has furnished large quantities. Quite recently great deposits were discovered in Wyoming, Idaho and Utah. On a smaller scale there are phosphate beds in Tennessee, Virginia and Pennsylvania. President Roosevelt withdrew from entry all public lands believed to be rich in phosphate.

Some authorities believe that we are facing a world famine as a result of the diminishing supply of this mineral, others take a more hopeful view. Experiments carried on in Illinois showed that in the upper seven inches of soil there were 1191 pounds of phosphorus, and that a corn crop yielding 75 bushels per acre used 17 pounds of this. At this rate the Illinois soils would be depleted of phosphorus in 70 years.

Three-fourths of the phosphorus drawn from the soil by plants is deposited in the grain of the plant, and the remainder in the stalk or straw. It is evident that a large amount of phosphorus could be saved annually by plowing under the straw, corn fodder and similar material, instead of burning it, as is frequently done.

Nitrogen is one of the three absolutely essential plant foods. More than three-fourths of our great atmospheric sea is nitrogen. This is *free* nitrogen, but that in the soils is in the form of *nitrates*, for example, nitrate of soda. This form is very soluble in water, and hence is found in large amounts in arid regions only. Northern Chile is a great storehouse of this material, and millions of dollars' worth are exported annually.

A few years ago the wonderful discovery was made that certain bacteria, minute plants belonging to the fungi, are able to take free nitrogen from the atmosphere and convert it into nitrates. The bacteria caused the growth of the tubercles upon the roots of leguminous plants such as peas, beans, alfalfa and peanuts. In these tubercles or nodules the nitrogen compounds are stored, and upon decay of the roots, the nitrogen is added to the soil.

The bacteria were discovered by the German scientist, Herman Hellriegel, but it remained for Dr. George F. Moore, of our Department of Agriculture, to work out a method of cultivating them. Farmers can now obtain from Washington packages of these useful plants. A package about the size of a yeast cake contains millions of germs. The bacteria are placed in a barrel of clean water, and the seeds of such plants as have been mentioned are soaked in the water. This gives to the plants added power to withdraw nitrogen from the atmosphere.

It has been found that a leguminous crop adds on the average 200 pounds of nitrogen per acre to the soil. Experiments have shown that cotton, when following a leguminous crop, increased

372 pounds per acre, potatoes 34.4 bushels, oats 52.2, and wheat 12 bushels.

As nitrogen eventually escapes back to the air, it seems evident that without the work of the nitrogen-fixing plants our supply would in time be exhausted. When the roots of these plants decay, the nitrogen is left in the soil. The decay causes the breaking up of the nitrogen compounds and the formation of nitrates.

Waste products obtained from slaughter-houses, steel and cement plants, and the wood and fish industries now supply large quantities of fertilizers.

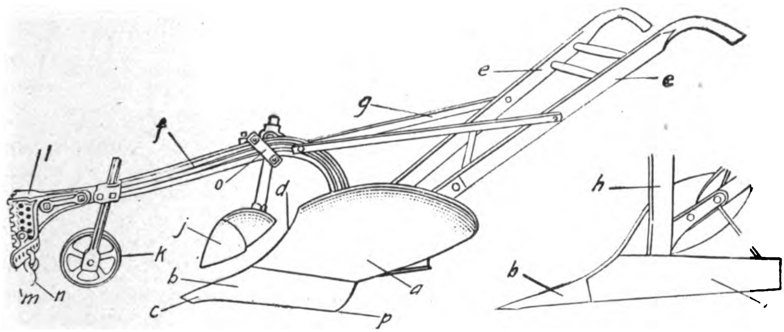

FIG. 59.—The parts of a plow: *a*, mold board; *b*, share; *c*, point; *d*, shin; *e*, handles; *f*, beam; *g*, brace rods; *h*, standard; *i*, landside; *j*, jointer; *k*, gauge wheel; *l*, bridle; *m*, beam clevis; *n*, hitch clevis; *o*, clamp; *p*, heel.

Rotation of Crops.—Different plants require different amounts of the various plant foods. Hence repeating any crop year after year exhausts certain foods, and the soil is said to have lost its fertility. The almost exclusive cropping of tobacco in Virginia in colonial days exhausted vast tracts of land. As little of the land was occupied, the planters kept placing new areas under cultivation.

Following clover by wheat, wheat by corn, and corn by potatoes, is an example of rotation of crops. In Germany this is extensively practiced. From what has been said it can be seen that some leguminous crop should be included in any scheme of crop rotation.

Although the belief is rather general that our soils are approaching exhaustion, it is held by some that this is not necessarily the case. Recent investigations carried on by the Bureau of Soils seem to indicate that under proper management the soil can be made to yield increasingly large returns. "It can be said, therefore, that the soil is the one indestructible asset of the Nation, which can be vastly improved by better and intensive methods, or which can be temporarily impaired by wrong usage."[2]

Cultivation of the Soil.—Today the manufacture of farm tools and machinery employs many persons and large amounts of capital. The labor-saving devices enable one man to care for many times as much land as he could formerly care for. Two acres represents a fair day's work for the old-fashioned plow. With a plow consisting of 20 "gangs" or individual plows, and drawn by an engine, 30 acres

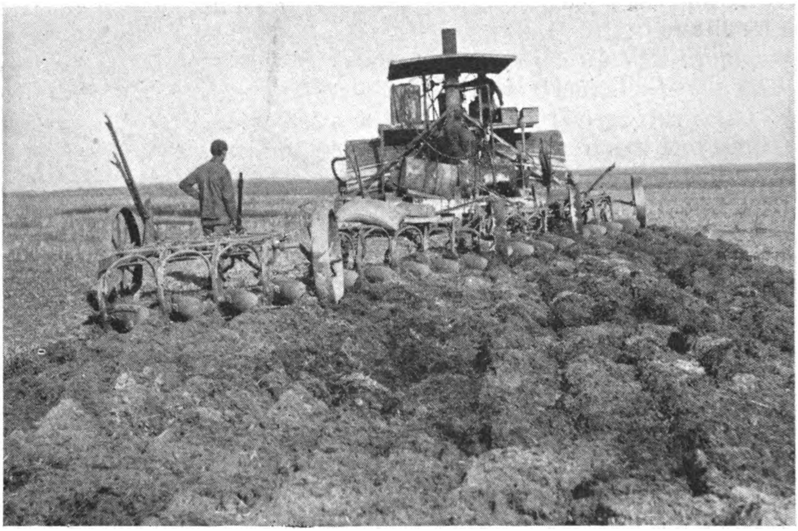

FIG. 60.—A gang-plow.

can be plowed in the same time. With the cradle of many years ago a man could cut three acres of wheat in a day. A modern harvester such as is used in the Pacific Coast States can cut 70 acres per day, and in addition thresh the grain and sack it.

Irrigating Crops.—In most parts of the world we depend upon Nature to supply plants with water, but for many years irrigation has been practiced in Egypt, India and China. Where Nature does the work, there are times when the plant receives too much water, and other times when it does not receive enough. Under artificial watering this can be regulated.

The amount of water required to mature a crop depends upon

[2] "Report of the Secretary of Agriculture." Yearbook, 1912, p. 151.

the character of the soil, the distribution of the water, cultivation, rate of evaporation, and the crop itself. For every pound of dry vegetable matter produced, such as straw or corn stalks, from 300 to 400 pounds of water are required. A crop of corn yielding 50 bushels per acre would require about 10 inches of water per acre.

FIG. 61.—Principal irrigation projects in the Western United States. (U. S. Reclamation Service.)

As approximately only one-third of the rainfall finds its way into the soil, we see that corn cannot be successfully grown without irrigation in regions having a slight annual precipitation.

In a wet soil plants develop many roots, but in a dry soil they do not. If the surface only be irrigated, there will be a strong growth of the roots in a superficial layer of the soil, and the crop cannot endure a drought, for it will not be able to draw upon deeper supplies. As

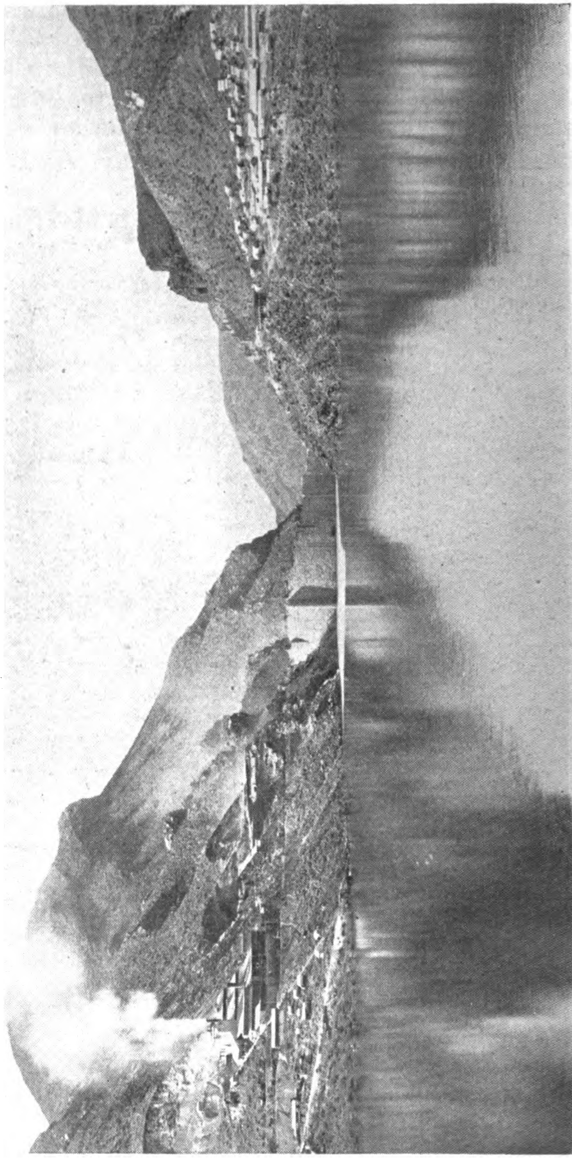

Photo by M. L. Gibbons.

Fig. 62.—Roosevelt Dam.

plant roots take in oxygen, it is easy to give a crop too much water. This cuts off the underground supply of oxygen, and in effect smothers the plant.

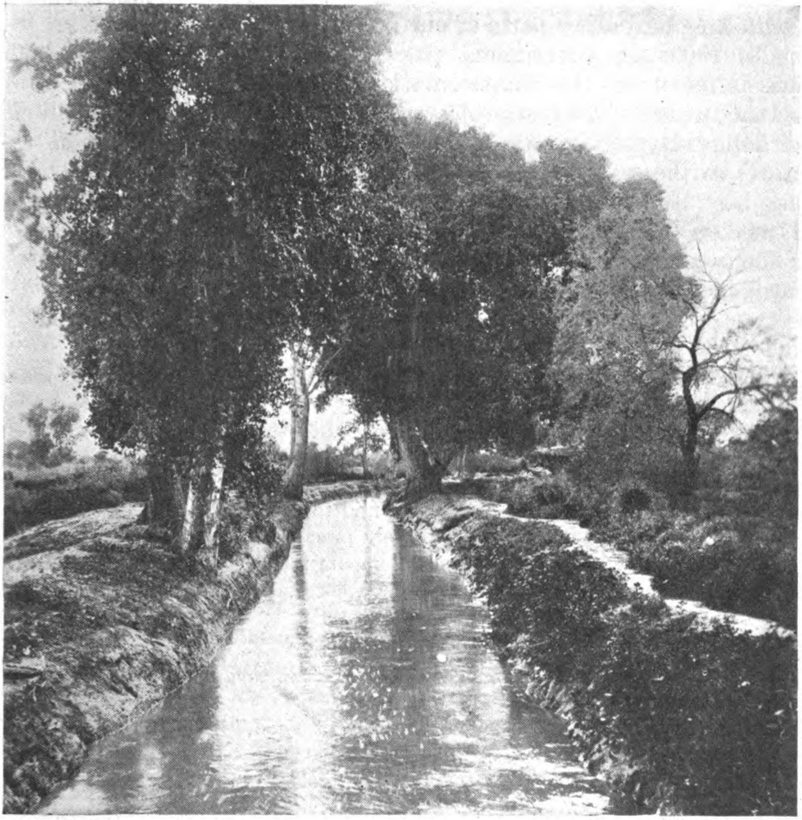

Photo by Ruth Huber.

FIG. 63.—Irrigation canal near Mesa, Arizona.

Social conditions in irrigated sections are quite different from those that obtain in humid regions. The development of water usually demands coöperation, and coöperation must be practiced in its distribution. As crops are more certain, larger and more frequent (sometimes several in a year) under irrigation than where rainfall is depended upon, farms are likely to be small. A man cannot work as large an area, and, owing to the advantage mentioned, the land is more valuable than non-irrigated farms.

Small holdings mean a relatively dense population. As a natural result good roads, rural delivery, telephones, libraries, schools and churches come early in the development of irrigated sections. Good illustrations are eastern Washington, southern Idaho, Utah, southern California, and other parts of our arid West.

In 1902 our government passed the Reclamation Act, which has as its object the transformation of arid lands into homes for actual settlers. The first project was opened in 1905. Many millions of dollars have been spent, and work has been done in all of the states in the semi-arid sections of the United States. Much work has been done by companies as well. In 1917 there were about 17,000,000 acres of irrigated land in our country. Areas which but a few years ago were barren wastes are now cut up into fruitful farmlands which support thriving towns.

STUDIES

Discuss the statement: Agriculture is the basis of human welfare. Is there a "back-to-the-soil" movement in this country? What is the average value per acre of agricultural land in your locality? What are the leading crops? Is most of the land tilled by those who own it? What is the condition of the roads in your county? Is agriculture taught in the schools? Examine the roots of leguminous plants, and see if you can find the nodules spoken of. In what parts of the world is irrigation extensively practiced? Contrast the farm life of today with that of 25 years ago. Compare farm life in the United States with that of China. Give illustrations of the value of co-operation among farmers.

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CHAPTER XVII

PLANT LIFE

General Statement.—Wonderful indeed are the works of man. So far as transportation is concerned, he has conquered the land, the sea, and to a certain extent, the atmosphere. He communicates with the most distant parts of the earth practically instantaneously. The energy developed from falling water he has harnessed to his manufacturing plants; at his will this energy conveys him from place to place, or dispels the darkness of night. Man can even preserve his own voice, so that long after he has passed away people may, if they desire, hear the tones in which he read, or spoke, or sang, and those who knew him will recognize the voice of the one who has gone. Yet with all of his power, man cannot create life, and he does not even know definitely what life is.

Two Divisions of Life.—We recognize two great divisions of life—plant and animal; hence we have the science of these two phases of life, *biology*. In many ways plant and animal life are very different, and yet there are certain resemblances. Formerly plants were not believed to be living organisms, but in the seventeenth century the botanist Jung declared them to be such.

Generally speaking, the power of locomotion distinguishes animals from plants, but there are some exceptions. Some animals, such as the coral, the starfish, and the oyster (except during the first few days of its existence), do not have the power of moving from place to place. Although the power of locomotion does not belong to plants, many of them have the ability to move, and such plants are said to be *sensitive*. Growers of rice often find in their fields a creeping plant called Mimosa. If the leaflets of its compound leaves are touched, or even disturbed by vibrations of the atmosphere, they will shrink, and the whole leaf will bend. On this account the Mimosa is sometimes called the *Shame plant*. Venus flytrap is another sensitive plant. The oxalis or sorrel, the clover and the California poppy are examples of plants that fold their leaves at night.

The Life Cycle of Plants.—The life of a plant may be very brief—only a few days, or even hours, or it may, as in the case of the *Sequoia gigantia*, those wonderful trees of California, represent centuries. In fact, according to our best authorities, some of those trees were old at the beginning of the Christian era.

Many plants develop from the seed to maturity and ripen their seed during one year. When they have, so far as it is possible for them, insured the perpetuation of their kind, their existence ceases. Such plants are *annuals*. Our cereals are examples. Other plants require two years for this work, and are therefore called *biennials*. Such are the carrot, parsnip, mullein, foxglove and teasel. Plants that persist for a number of years are known as *perennials*. Our common fruit and shade trees are familiar examples.

Man's Dependence Upon Plants.—All animal life, including that of man, depends for its existence upon plants. Animals must have organic substances to use as food, but plants manufacture their foods from inorganic substances. In other words, the only way in which our food supply can be perpetuated or added to is through the work of plants. Plants are factories in which the food for all life is manufactured. This is the primary relationship between plants and man, but there are many other important ones.

Plants furnish the fibers from which much of our clothing is made. Wood enters into the construction and furnishing of most houses. We travel from place to place in conveyances made in part of wood. Our newspapers are made from wood-pulp. Not unimportant is the value of plants from the æsthetic point of view. Trees cast a grateful shade upon the homes of rich and poor, and the forest furnishes inspiration to those who visit it. Flowers convey a message of joy to the beholder no matter what his race or language. It is therefore in the highest degree instructive and interesting to know some of the fundamental principles that govern plant life.

The actual or apparent death of a multitude of plant forms each autumn, and the renewal of life each spring, is a phenomenon familiar to all. A seed may remain in the ground all winter and not germinate, yet with the return of warm weather it bursts into life. This annual resurrection of plant life is a most beautiful and a most marvelous thing.

"All silently and soft as sleep,
The snow fell flake on flake.
Slumber, spent earth, and dream of flowers
Till spring-time bid you wake.
Again the deadened bough shall bend
With blooms of sweetest breath.
Oh, miracle of miracles,
This life that follows death!"[1]

[1]Aldrich: "Resurgam."

The temperature best suited to germination and growth varies with different plants, but no growth takes place at temperatures below that of freezing. Some plants are killed by temperatures even above the freezing-point, as, for example, the cotton and the melon. The low temperature stimulates the protoplasm to give up water. The roots fail to supply the leaves with sufficient water to offset the amount lost by transpiration, and therefore they wilt and blacken.

Water is another essential to plant growth. Water penetrates the earth to considerable distances, and, where there is abundance, forms a film around each soil particle. This moisture, which is known as *hygroscopic* water, is by the process of *osmosis* (which is the diffusion of liquids through membranes) taken in by the root-hairs and distributed to all parts of the plant. The root-hairs, although very minute, are made up of cells containing protoplasm and cell-sap. The liquid passes from the cells in which the density of the sap is less to those in which it is greater.

As the density of the cell-sap is greater than that of the water, the water enters the root-hairs. This lowers the density of the cell-sap, and the water therefore passes into the cells above. The continuation of the process carries the water to the leaves, where the excess is thrown off. Water gives the stalks and leaves rigidity and the distended condition known as *turgor*, without which normal growth cannot take place.

From the atmosphere the plant must derive oxygen and carbon dioxide gas. These enter the plant through tiny openings, chiefly on the under surface of leaves, called *stomata*. Sunlight for green plants, and soluble salts obtained from soil water by all plants, are other essentials for plant growth.

How Plants Manufacture Food.—As has been stated, most animals possess the power of locomotion, and they therefore search for their food. A long train of consequences follows this. The senses of sight, hearing, taste, smell and touch are necessary, and are highly developed. Plants are constantly in contact with the sources of their food supply, the atmosphere and the soil. The senses are therefore (with the exception of the last) not developed.

From the atmosphere the leaves of plants absorb carbon dioxide gas. *In the presence of sunshine the chlorophyl*, or coloring matter, of green plants causes the carbon to unite with the elements of water, forming a starch or plant food, which is built into the cells. As a part of this process, which is known as the process of photosynthesis, oxygen is set free. Plants in a room absorb some of the carbon dioxide gas exhaled by people. They may therefore be said to purify the atmosphere of rooms, but this applies to the day only, as during the darkness the process of growth is not carried on by green plants.

Carbon enters into the composition of all plants. In other words, all of our grains, vegetables, fruits and berries that we use as food are in part made up of carbon which they have taken from the air.

The essential mineral foods of plants drawn from the soil are nitrate, potash, phosphorus, potassium, calcium, magnesium, sulphur, iron and chlorine. The three first named are the most vital. These foods are taken in the form of soluble salts by the process of osmosis. In order that enough food may be obtained, the plant draws from the soil much more water than it can use. The process of eliminating the surplus is called *transpiration*. This moisture adds to that which collects upon plants during the formation of dew. In order to regulate the process of transpiration, the stomata contract or expand as occasion requires.

Reproduction.—That an acorn should produce a giant oak, and a flinty kernel of corn a corn plant, is a wonderful thing. The essential element of life, whether in the plant or the animal, is the cell, which is composed of a substance known as protoplasm, or bioplasm (life substance), usually in a semi-fluid condition. Under proper stimuli the cells develop into plants or animals.

When we plant a seed we know that if it grows it will produce a plant of the same *genus* as that from which the seed was obtained. It will not, however, always produce a plant of the same *variety*. Thus, by selection, growers develop new varieties.

For the reproduction of plants by means of seeds, Nature makes lavish provision. This is necessary, since many seeds do not mature, many are destroyed, and many do not fall where they can germinate. Gibson says that it is believed that shepherd's purse, a common weed, produces 12,000 seeds annually, the burdock 40,000, and purslane 2,000,000. Unless some checks were imposed, a single plant would in a few years take possession of all of a continent where climatic conditions favored its growth.

Plants may be reproduced by *budding*, and this insures propagation true to variety. In this process a leaf-bud, called a *scion*, is inserted into a cut between the bark and the wood of another plant called the *stock*. Where grafting, which is a form of budding, is practiced, the bud is inserted into a cut in the wood of the stock. Budding or grafting is used in propagating most fruits. For example, orange trees are secured from orange seeds planted in nurseries, but to ensure fruit of the desired variety the young trees are budded by means of buds taken from trees of the given variety. If desired, several varieties of citrus fruits, or of peaches or apricots, may, by budding, be obtained from one tree. This is practiced to some extent where the grower has a very small piece of land.

Dispersal of Plants.—For the dispersal of the plant there are various means provided. In some cases the seeds are in a fleshy pulp, which birds eat. The seeds are thus widely distributed, and as digestion of the pulp does not injure them, the range of the plants is greatly increased.

Those who walk along country roads or in fields or woods in the autumn frequently find many burs, spines or hooks clinging to their clothing. Large numbers of these cling to the hair, fur or wool of wild and domesticated animals. These burs and similar attachments furnish a very effective means of seed dispersal. Certain plants, such as sweet peas, beans, violets, locust and witch hazel, have seed pods that explode, and thus scatter their contents for short distances.

In the case of plants the seeds of which are provided with wings or parachutes we have another very interesting means of dispersal. Some cone-bearing trees are thus provided, as are the elm, catalpa, maple, ash and tulip-tree. Among smaller plants the thistle, milkweed and dandelion are familiar examples.

Man changes the distribution of plants much more rapidly than does Nature. In a single day he can carry seeds or plants farther than they could be distributed by natural means in centuries. More than this, he easily carries the plants across barriers which Nature can never overcome, such as the ocean and very lofty mountains.

Think of what this has meant in the case of corn, a native of America; of wheat, probably a native of Palestine; of the potato, probably a native of Chile; of rice, a native of India; of cotton, which seems to have originated in Arabia or India, and of many other very useful plants now widely distributed. No cereals were indigenous to Australia, therefore the development of that continent depended in no small degree upon the introduction of these useful plants.

Greatly as man has changed the natural distribution of plants, he cannot succeed in getting a plant to grow in regions that are entirely unsuited to its growth. Only within certain limits can man modify life forms.

Natural Protection.—In various interesting ways nature protects plants. There are striking cases in arid regions. The leaves of the eucalyptus hang with their edges toward the sun to reduce transpiration. The cactus has thick leaves for the storing of water, and is armed with spines which ward off the attack of animals.

At the beginning of a dry or a cold season many trees drop their leaves. This is a natural and effective means of protecting plants. Water in the form of ice is of no use to plants, hence during very cold as well as during very dry weather the roots do not furnish a supply of water. Under these conditions the plants would suffer the loss

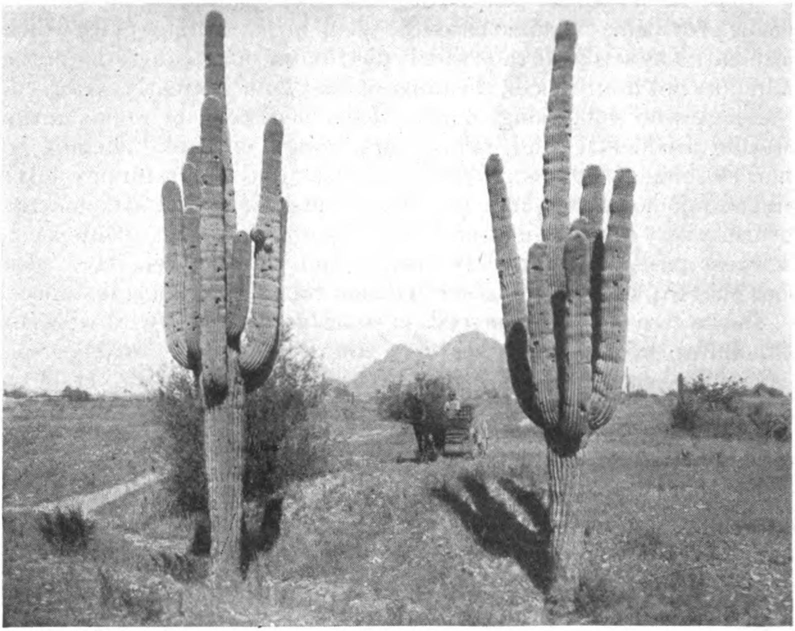

Photo by Ruth Huber.

FIG. 64.—Desert vegetation.

of water through transpiration if they retained their leaves, especially large ones. In many cases this loss of water would result in the death of the part of the plant above ground.

STUDIES

Make a list of the useful plants in your locality. What plants have been introduced? What useful plants will not grow in the vicinity? Make a study of dispersal and protection as illustrated by plants in your neighborhood. What local industries are dependent upon plant life?

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CHAPTER XVIII

THE CEREALS

General Statement.—The cultivation of the soil was the chief factor in transforming human beings from wanderers into creatures having fixed places of abode. Many centuries ago it was discovered that the seeds of certain grasses were very valuable as food. These plants were cultivated, and as a result of cultivation they were greatly improved. From these grasses have developed our cereals of today, the most important of which are wheat, corn, rice, oats, barley and rye.

The great industry of agriculture is largely concerned with the cultivation of these plants. Directly and indirectly the inhabitants of the world depend upon them for a large part of their food supply. Their cultivation is closely related to stock-raising, the leather and liquor industries, the manufacture of agricultural tools and machinery, and transportation facilities.

Corn.—The average farm value of the corn crop of the United States for the years 1907 to 1916, inclusive, was about $1,550,000,000. This is much greater than the value of all the gold produced in the world during any one of these years. If this money were equally divided among the inhabitants of the United States it would give approximately $15.00 per year to each man, woman and child. The average farm value of corn per acre for the period mentioned was about $16.00. Corn is the most valuable crop grown in our country.

The corn plant, which is a member of the grass family, is native to the Western Hemisphere, but through the efforts of man it has been widely distributed in both the Old and the New Worlds. It is believed by some that corn originated in Mexico or Central America. At the time of the discovery of our continent by Columbus, the Indians used corn as a food, and Columbus carried seed from the West Indies to Europe. Cartier found corn fields where Montreal now stands. The early settlers in various parts of America learned from the Indians how to cultivate the crop, and bought large quantities of the grain from them.

For its successful cultivation corn requires a greater annual rainfall and a higher temperature than does wheat. The summer temperatures in the British Isles are too low for the growing of corn.

although one may occasionally see a corn plant in a garden. Across the English Channel, in France, corn does well. This furnishes a striking illustration of the influence of the ocean upon temperature. The absence of a corn crop in the British Isles is one reason why so few hogs are raised there. Most of the pork consumed in these islands is therefore imported.

The date of the first killing frost is very important as applied

FIG. 65.—A corn field.

to the corn crop. For example, the first killing frost of some particular autumn may be two weeks or even one month earlier than the average date of the same event. This would usually mean a tremendous loss.

In this country machinery is very largely used in connection with the corn crop. On the large farms gang-plows are usually employed. The seed is planted by machinery, and the cultivating is done by a machine, which the operator rides. On some farms the corn is husked by means of machines propelled by gasoline engines.

About three-fourths of the corn crop of the world is produced in the United States. Other important corn-growing countries are Argentina, Austria-Hungary, Rumania, Italy, Russia and Egypt. Fig. 67 shows the chief corn-growing states in our country. Of these

Iowa and Illinois are the most important. Although the states in this group produce the bulk of the corn crop, their yield per acre is not so high as is that of some of the other states. For the years 1908 to 1917 inclusive, the average yield per acre in Iowa was 35 bushels; in Illinois, 34 bushels; in Maine, 41 bushels; and in New Hampshire, 42 bushels.

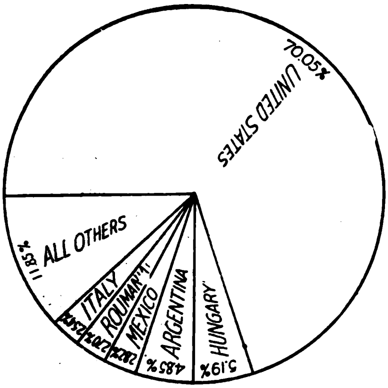

FIG. 66.

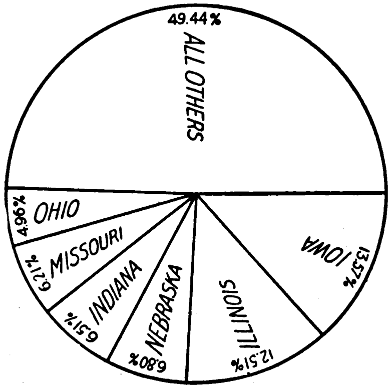

FIG. 67.

FIG. 66.—World's production of corn. Percentages by countries. 1913-1918 inclusive.
FIG. 67.—Production of Corn in United States. Percentages by states. 1914-1918 inclusive.

TABLE 1.

AVERAGE YIELD OF CORN PER ACRE IN THE UNITED STATES BY TEN-YEAR PERIODS.

Years	Bushels
1870 to 1879	27
1880 to 1889	24
1890 to 1899	24
1900 to 1909	25
1910 to 1917	26

During the decade ending in 1918 the value of the corn crop in the United States increased 100 per cent. In 1909 one-fifth of the cultivated land in our country was devoted to corn. In 1910 the value of the corn crop in the various states in the corn belt ranged from 35 to 53 per cent. of the value of all crops in the same states.

On page 5 in the Farmers' Bulletin Number 199 occurs the following statement: "It is possible within a few years to double the average production of corn per acre in the United States, and to accomplish it without any increase in work or expense."

The figures quoted above are encouraging, for they show that some increase has already occurred. More careful selection of seed, improved methods of cultivation and fertilizing of soil, and more scientific rotation of crops will accomplish much.

Although our corn crop is so enormous, only about three per cent. of it is exported. It is more profitable to convert the corn into beef, pork and poultry than it is to market it in its original form, and feeding the corn keeps the fertilizer on the farm. The industries of hog raising and pork packing are very closely related to that of corn growing. Hence we find great numbers of hogs kept in the corn belt, and here are located the great pork-packing centers, Chicago, St. Louis, Kansas City and Omaha. About three-fourths of the corn grown in the corn belt is fed to stock.

Although corn has its greatest value when converted into meat and its by-products, it is in itself valuable as a food for human beings. It is rich in starch and sugar. Corn bread and corn cakes are extensively eaten in this country, in Mexico, and in southern Europe. In the manufacture of glucose a large quantity of corn is used.

Starch, beer, and alcohol are other important products of corn. The leaves are used to some extent in the manufacture of paper; the husks are used in mattresses, and the cobs are made into pipes and are used as fuel also. Corn stalks are used as a summer and winter feed for cattle, and as a fertilizer. The poet spoke truly when he said, "No richer gift has Autumn poured from out her lavish horn."

Wheat.—For thousands of years wheat has been cultivated. In fact it is believed by some that agriculture began with the cultivation of this cereal. A few years ago there was discovered in Palestine a wild wheat which botanists think is the ancestor of the cultivated forms. This wild wheat resists both drought and smut, and therefore it may be possible to derive from it varieties which will be adapted to semi-arid regions, and at the same time produce larger crops than does the wild plant.

Wheat is the most valuable of food plants, and of all cereals only rice is used by a larger number of people. The latitudinal and altitudinal range of wheat is great, being cultivated from Alaska and Siberia to the Argentine Republic, and from sea level to altitudes of many thousand feet in the tropical zone. It grows in regions where long, severe winters occur, and in the winterless valley of California. It thrives in moist and in arid sections. The crop reaches its greatest perfection, however, where the spring is damp and rather cool, and the summer warm and dry. It does not need as high a temperature as does corn; hence the wheat belt in our country lies to the north of the corn belt.

The United States ranks foremost among the nations of the world as a wheat producer, our crop amounting to about twenty per cent. of the world's supply. Other important wheat-growing countries are: Russia, France, India, Austria-Hungary, Italy, Germany, Rumania, Argentina and Canada. With the exception of Russia, France, Austria-Hungary and Rumania, all European nations are wheat buyers. The United States, Russia, Argentina, Rumania, India, Canada and Australia are the chief wheat sellers.

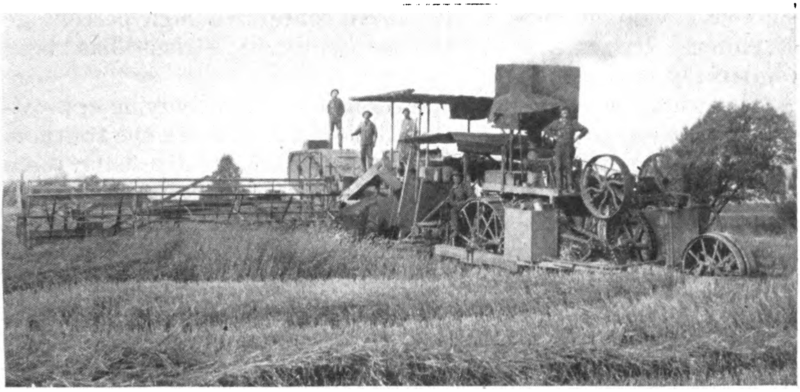

FIG. 68.—Harvesting wheat.

As Fig. 70 indicates, our chief wheat-growing states are North Dakota, Kansas, Minnesota, Nebraska, Washington, South Dakota, Illinois, Indiana, Missouri and Ohio. About three-fourths of our entire wheat crop is grown in these states. Since 1900 the increase in our output has been about 40 per cent. The wheat for 1917, if equally distributed, would have given to each person in the United States about 6 bushels.

The chief wheat-producing states are not those that yield the largest number of bushels per acre. The average yield in Nevada, which is very unimportant as a producer, was for the years 1908 to 1917 inclusive, 29 bushels per acre. For the same period the yield in Montana was 23 bushels, in North Dakota 11 bushels, and in Minnesota 14 bushels. For the United States the average yield for the same period was 15 bushels per acre.

Our vast tracts of level fertile lands; our cheap transportation facilities; our scientific methods of agriculture, and our labor-saving devices for handling the grain, make it possible for us to compete with Russia for the markets of western Europe.

Largely through the work of our Department of Agriculture, the value of our wheat crop has increased enormously. In 1899 the importation of durum wheat from Russia east of the Sea of Azof began. Later it was found that a better variety, known as Kubana wheat, was grown in the Kirghiz Steppe district of western Siberia. Practically all of the durum wheat grown in the United States is of this variety. This wheat is quite resistant to drought, smut and rust, and will flourish in soils having considerable alkali. Another point of advantage is that this wheat contains a high percentage of gluten. Its cultivation in the semi-arid regions has been wonderfully successful.

This wheat does best in that portion of our country lying approximately between the 95th and the 105th meridians. In the southern part of this great belt wheat growing has not until recently been successful, owing to lack of rainfall. As the precipitation here is somewhat in excess of that in the section of Russia from which the durum wheat came, it has produced splendid crops.

The total cost of the experimental work, which covered a period of three or four years, was about $10,000. Our crop of durum wheet is now worth many millions of dollars annually, and we are exporting large quantities, chiefly to the Mediterranean countries, because of its splendid value in the manufacture of macaroni.

Wheat is classed as *winter* and *spring* wheat. Winter wheat is sown in the autumn and harvested in the early summer. The snows of winter protect it, but a winter with little snow is unfavorable. Spring wheat is sown in the spring and harvested in the fall. Wheat is also classed as *hard* and *soft*. Hard wheat contains much gluten, and is of special value in the manufacture of macaroni. Soft wheat is rich in starch.

In the preparation of the ground for the seed, gang-plows are, on the larger farms, commonly employed. These turn several furrows at once, both horse- and steam-power being used. The soil is usually pulverized and harrowed, and the seed sown by machinery. After seeding, the ground may be rolled, especially if the farm be not very large.

The harvesting of wheat on a Western ranch is a great sight. A machine known as a combined harvester, drawn by twenty or thirty head of horses or mules, or by an engine, cuts the grain at the rate of 50 to 70 acres per day. The machine cuts the grain, threshes it and sacks it. The sacks are sewed up by two men riding on the machine. The filled sacks are dropped automatically, several in a place, and the straw is dropped in piles.

As summer rains do not occur in the wheat belts of the West, the wheat harvest proceeds for weeks without interruption. The sacks of grain are often piled up in the fields, thousands in a pile, to await shipment. This method of handling wheat cannot be employed in humid regions.

Handling the annual wheat crop in our country is a great undertaking. From the fields of eastern Washington and Oregon it goes in part to mills at Spokane, which derive power from the falls in the Spokane River, and in part to Portland and Puget Sound ports, from which both wheat and flour are shipped to the Orient. In addition to the countless trains that bear the crop from the wheat fields of the North Central States to the centers of population and points of export, the "Soo" canals are taxed to their utmost during the period of open navigation.

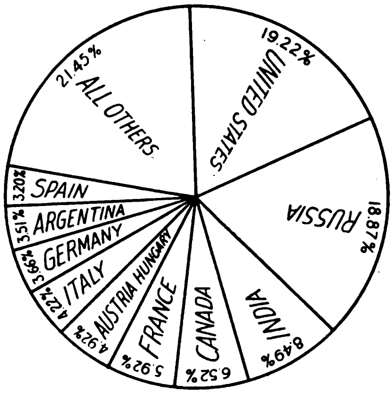

FIG. 69.—World's production of wheat, 1913-1917 inclusive.

About fifty per cent. of our wheat crop is grown in the ten states tributary to the Great Lakes. This is a great advantage from the standpoint of transportation. For the five years ending in 1910, the average cost per bushel for transporting wheat from Chicago to Buffalo by the Great Lakes was 1.4 cents. In 1918 the average cost per bushel from Chicago to New York by way of the Great Lakes and the Erie canal was 12.53 cents. The cost of all-rail shipment during the same year was 16.24 cents.

The per cent. of our total crop exported is decreasing. In 1907 it amounted to 25 per cent. The average for the five years ending with 1913 was 15 per cent. In 1914 we exported 37 per cent. of our total crop, and in 1917 about 32 per cent. A large part of what we export goes to the densely populated countries of western Europe. We export a great deal of flour, the number of barrels in 1914 amounting to about 12,000,000.

Whether or not a country supplies itself with wheat depends upon economic conditions. Previous to 1846 the "Corn Laws" of Great Britain placed an import duty on wheat. As time passed it became evident that it was more economical for the people to engage in manufacturing and in commerce than to till the soil. The laws were therefore repealed. The British Isles now produce about one-third of the wheat consumed by their people.

On the vast plains of southern Russia, known as the "Black Earth" region, are wheat fields second only in extent and quantity of wheat produced to those of the United States. Owing to primitive methods of agriculture, and lack of fertilizer, the yield per acre is not large. Odessa, on the Black Sea, is the great wheat-exporting center of Russia. The quantity exported is greater than it otherwise would be, because the peasants very commonly use rye, which is, of course, cheaper. In the basin of the Danube, on the plains of Hungary, much wheat is produced.

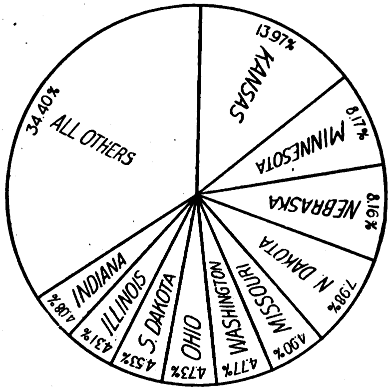

FIG. 70.—Production of wheat in the United States. Percentages by states. 1914-1918 inclusive.

Minneapolis holds first place among the cities of the world as a wheat-milling center. It is in close proximity to the great wheat fields of the Nortnwest, and it has abundant power afforded by the Falls of St. Anthony. Formerly wheat was ground between two stones, the distance between them determining how fine the grain was ground. Now the wheat is ground between steel or porcelain rollers; as many as six or seven sets sometimes being used. After the first grinding, the flour is bolted to take out the bran.

When ready for shipment the flour is put up in sacks or barrels. In the great centers of population the baking of bread is an important industry, and its delivery employs a large number of persons.

The future supply of wheat is a matter of great importance. The population of the earth is increasing steadily, and the use of wheat is being extended in countries where its consumption has been very limited in the past. China, Japan, and the Philippine Islands are illustrations. In addition to this, the area of unused land is decreasing. The introduction of drought-resisting varieties, the extension of irrigation, and the development of scientific agriculture generally, will do much toward solving the problem.

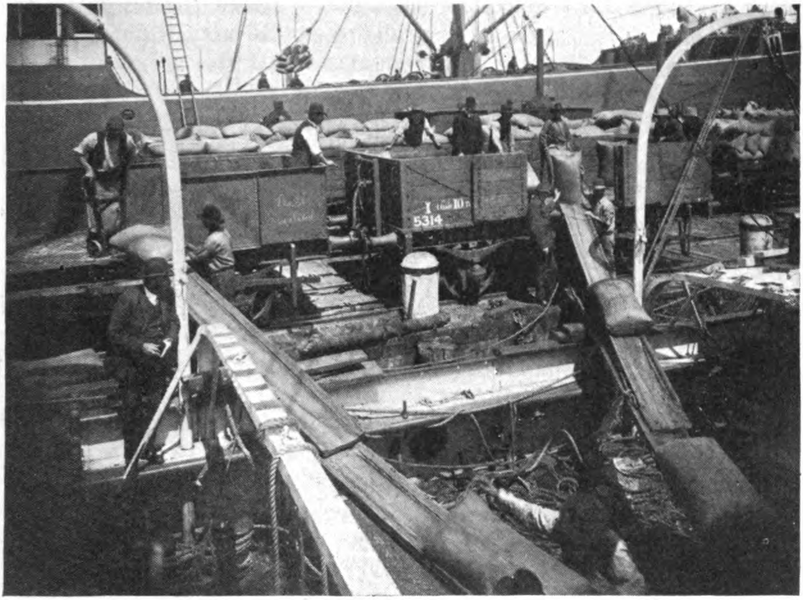

FIG. 71.—Loading wheat at Melbourne, Victoria. (Courtesy F. T. A. Fricke, Gov't. Representative from Victoria, Australia.)

TABLE 2.

AVERAGE YIELD OF WHEAT PER ACRE IN THE UNITED STATES BY TEN-YEAR PERIODS.

Years	Bushels
1870-1879	12
1880-1889	12
1890-1899	13
1900-1909	14
1910-1918	15

In this connection it is instructive to compare the average yield in our country with that in some others.

TABLE 3.

AVERAGE YIELD OF WHEAT PER ACRE, 1905-1914 INCLUSIVE.[1]

European Russia	10 bu.	(1905-1913)
United States	15 bu.	
Hungary	18 bu.	
Austria	20 bu.	(1905-1913)
France	20 bu.	
Germany	31 bu.	
United Kingdom	33 bu.	

There appears to be no reason why the yield in the United States cannot be made to equal that of Germany or the United Kingdom. If, without adding an acre to the area devoted to wheat growing, we could increase the yield from 15 bushels per acre to 20 bushels per acre, we should add more than 270,000,000 bushels to the annual crop.

Oats.—Oats has a wide distribution. It does well in a cooler and more moist climate than that best adapted to the growing of wheat. The great oats-producing countries of the world are: the United States, Russia, Germany, Canada, France, Austria-Hungary and the United Kingdom.

As a producer of oats, the United States holds first place, our yield being about one-third of the world's crop. In 1918 the crop in the United States amounted to 1,538,359,000 bushels. This was the record crop for our country, and was about 26,000,000 bushels above the average for the five preceding years. The total farm value of the crop in 1918 was $1,000,000,000, or nearly double the average value. In 1909 the area devoted to oats in the United States was 7 per cent. of the total area cultivated. The average yield per acre in the most important oats-producing countries is indicated below.

TABLE 4.

YIELD IN BUSHELS PER ACRE, 1905-1914 INCLUSIVE.[2]

Country	Bushels	
European Russia	21	(1904-1913)
United States	29	
France	31	
Hungary	32	
Austria	33	(1904-1913)
United Kingdom	44	
Germany	54	

[1] Yearbook, U. S. Dept. of Agriculture, 1915, p. 420.
[2] Yearbook, U. S. Dept. of Agriculture, 1915, p. 431.

These figures indicate that we can greatly increase the yield of oats in this country without increase in the acreage devoted to the crop.

Fig. 73 shows the oats belt in the United States. For the five-year period ending in 1917 the following were the leading states in the production of oats: Iowa, Illinois, Minnesota, Wisconsin, Ohio, Nebraska, South Dakota. Iowa and Illinois produce about as much as the remaining five states in the belt.

Owing to its bulk, and to the fact that it is chiefly used as a feed for horses and mules, oats does not enter in a large way into the commerce of the world. We export some, chiefly to the British Isles, France and Belgium.

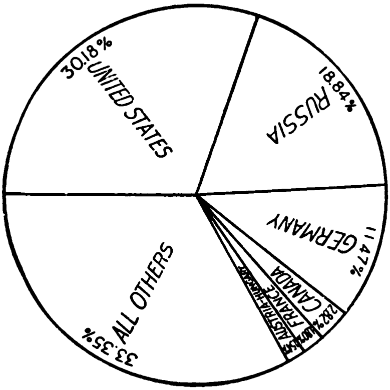

FIG. 72

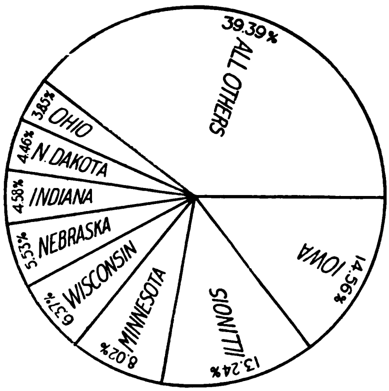

FIG. 73

FIG. 72.—World's production of oats. Percentages by countries. 1913-1917 inclusive.
FIG. 73.—Production of oats in the United States. Percentages by states. 1914-1918 inclusive.

The people of Scotland use large quantities of oatmeal, owing, in part at least, to the fact that oats flourish in the cool, moist climate of Scotland. The use of oatmeal is increasing in the United States.

Rye.—Rye will flourish at a lower temperature and in weaker soils than will wheat, and therefore it is cultivated in high latitudes and high altitudes. In Russia much of this cereal is grown far to the north of the "Black Earth" zone; and in Norway, owing to the moderating influence of the ocean, it is cultivated as far north as the Arctic Circle. Rye is extensively produced on the weak, sandy soils of northeastern Germany.

Russia far outranks all other countries in the production of rye. Indeed, it produces nearly as much of this cereal as do all other countries combined. Germany ranks second, and Austria-Hungary, France and the United States are large producers.

TABLE 5.

AVERAGE YIELD OF RYE PER ACRE FOR THE YEARS 1905-1914 INCLUSIVE.[3]

Country	Bushels per acre	
European Russia	12	(1904-1913)
United States	16	
France	17	
Hungary	18	
Germany	27	
Ireland	29	

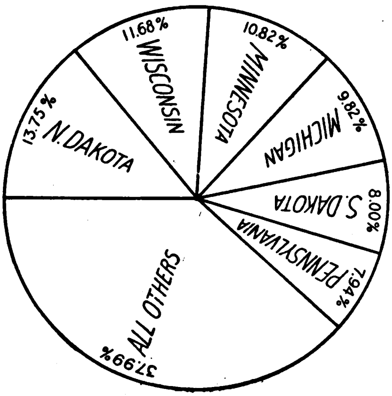

FIG. 74.—Chief rye-producing states.

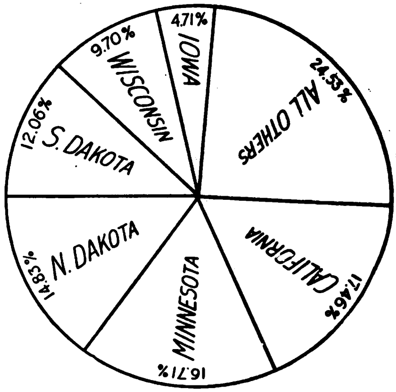

FIG. 75.—Chief barley-producing states.

Our chief rye-growing states are Wisconsin, Minnesota, Pennsylvania, Michigan, New York and New Jersey. These six states produce a very large part of our total yield.

In Europe rye is the poor man's breadstuff, constituting the chief food of a considerable part of the population. From it is made the "black bread" so largely used by the laboring classes in Russia, Germany, Scandinavia, and Austria. In the United States rye was formerly chiefly used in the distilling of whiskey. In Holland it is used in the manufacture of gin, and in Russia, until recent years, in the manufacture of vodka.

The straw of rye, being long and tough, is used in making straw hats, and to some extent it enters into the manufacture of ropes and mats. In some parts of Europe houses are thatched with this straw.

[3]Yearbook U. S. Dept. of Agriculture, 1915, p. 446.

Barley.—Barley is the most widely distributed of the cereals. It matures in Norway north of the Arctic Circle, and in Liberia within ten degrees of the equator. It ripens where the growing period is shorter and the average summer temperature lower than they are in the regions adapted to other grains. Russia is by far the most important barley-producing country in the world. The United States, Austria-Hungary, Germany, Spain, Japan and Algeria grow large quantities.

Fig. 75 shows the chief barley-growing states in our country. For the years 1912 to 1917, inclusive, Minnesota, California and North Dakota produced about one-half of our total crop of barley.

As wheat commands a higher price than does barley, the latter is extensively used in bread-making in Russia, Germany and Norway. In Norway, what is know as "flat bread" is made from this cereal. The dough is rolled into large thin sheets and then spread upon a flat stone or iron plate, under which there is a fire. After baking, the bread is stored in a dry place for winter use. Pearl barley is used in making soups and gruels.

TABLE 6.

YIELD OF BARLEY PER ACRE, 1905 TO 1914 INCLUSIVE.[4]

Country	Bushels
European Russia	15 (1904-1913)
Hungary	25
France	24
United States	25
Austria	27 (1904-1913)
United Kingdom	35
Germany	37

Rice.—This cereal has been cultivated for thousands of years. It is said to be indigenous to India, and to have been introduced into China 3000 years before the beginning of our Christian era and into America in 1694. Although rice contains more starch than any other cereal, it is, as compared with wheat, deficient in nourishing qualities, but it is agreeable to the taste, easily digested, and a grain that is especially adapted to many of the densely populated portions of the Orient. Rice is therefore the staple food of about one-third of the inhabitants of the globe. It is not a very important article of commerce, as it is largely consumed in the countries where it is grown. We grow about one-half the quantity consumed in our country, importing the remainder from Asia.

[4]Yearbook, U. S. Department of Agriculture, 1915, p. 439.

Although there are many varieties of rice, there are two kinds of most importance: swamp and upland rice. The first-named variety is grown upon the fertile lowlands that can easily be irrigated, such as the deltas of the Hoang-ho, Menam, Po and Mississippi. Upland rice is grown upon land that is not irrigated.

In the United States rice is sown in the fields, sometimes by machinery and sometimes by hand, but in the Hawaiian Islands, the Philippines, Japan and some other regions the swamp rice is sown in nursery beds and transplanted by hand, the work being done

FIG. 76.—Plowing a rice field in the Philippines.

when the fields are covered with water. The fields are flooded at intervals until the grain blossoms. The water is then drawn off in order that the grain may ripen more rapidly, as well as to allow the ground to dry preparatory to harvesting the crop.

While lowland rice is grown on deltas near sea level, salt water is injurious to the crop. So also is flood water, because its temperature is lower than that of the water used in irrigation. The fields are therefore protected by means of levees.

In the Orient, rice is cut by hand, and this method of harvesting was, until recently, employed in our country, because the moist condition of the soil makes it difficult to use machinery. Harvesters having wheels with wide tires are now in use on the large plantations in Texas and Louisiana. This has stimulated rice-growing in the United States.

The first operation after harvesting is the threshing of the crop. The *paddy*, which is the name given to the grain before the hulls are removed from the kernels, is then put through the hulling machine. The grain is next screened to separate the whole kernels from the chaff and broken bits. This refuse is made use of as a packing material, and in some cases it serves as fuel in factories.

Polishing the kernels is the next operation. This gives them a white appearance, which increases the selling price but decreases the value of the grain, for it removes some of the nutriment. The *rice flour* that results from the polishing is said to be 1¾ times as valuable as a food as is polished rice.

From one to three bushels of rice are sown to the acre, and about thirty bushels per acre constitutes an average crop in the United States. The cost of producing the crop, including interest on the money invested, is about $25.00 per acre. The following table is taken from Farmers' Bulletin No. 110, p. 19:

TABLE 7.

NUMBER OF ACRES ONE MAN CAN FARM IN RICE, WITH WAGES IN DIFFERENT COUNTRIES.

Countries	Acres	Farm wages in gold per year, with board
Japan	½	$10.00 to $18.00
China	½-2½	$ 8.00 " $12.00
Philippines	2½	$15.00 " $20.00
India	3	$10.00 " $20.00
Siam	3	$10.00 " $20.00
Egypt	4	$15.00 " $30.00
Italy	5	$40.00 " $60.00
Spain	5	$40.00 " $60.00
United States	8-80	(estimated) $300.00 " 500.00

This table shows that although the wages paid in this country are far in excess of those paid in the Orient, our rice is produced more cheaply than is rice in the East. This is because of the use of machinery in the United States. The area in our Southern States well adapted to rice-growing is only in part utilized, and our output can be very greatly increased. Rice is now being successfully grown in California, 80,000 acres being devoted to the crop in 1917, and the area can be very greatly increased. "There is no satisfactory reason why the United States should not grow and mill all of its own rice, and become an exporter."[5]

Rice-growing is very profitable on the lowlands near Valencia, Spain. It is reported that in that locality good rice land sells at from

[5] Farmers' Bulletin No. 110, p. 28.

$700 to $1,000 per acre. In British Burmah and in Lower Bengal from 80 to 90 per cent. of the cultivated land is in rice.

The great rice-growing countries are: India, China, Japan, Java, Siam and Korea. Many other areas produce considerable quantities. Rice requires a high temperature, a growing season of 135 days, an abundance of water, and a relatively impervious underlying soil. Its distribution is therefore limited. Its extreme latitudinal boundaries are approximately 45° north and 30° south of the equator, and its temperature limits are roughly indicated by the annual isotherms of 60° F.

FIG. 77.—A rice field in United States.

Fig. 79 shows the states that constitute the rice belt in our country. Of these Louisiana, Texas and Arkansas rank in the order named. In 1915 Louisiana produced nearly one-half of our total crop.

TABLE 8.

AVERAGE ANNUAL YIELD OF RICE FOR THE FIVE-YEAR PERIOD ENDING WITH 1913.[6]

Country	Pounds
British India	73,544,265,000
China	47,204,000,000 (estimated)
Japan	10,562,400,000
Java and Madura	7,591,090,000
Siam	4,658,151,000
Korea	2,480,046,000
United States	681,166,000
World (1908-1912)	169,585,133,000

[6] From Yearbooks, U. S. Dept. Agriculture.

Rice is of the greatest economic importance in many Oriental countries. In addition to its use as a food, the people of Japan use the straw in making mats, ropes, bags, hats, raincoats, sandals and a thatch for houses. From the grain they make a popular liquor called *saki*. In the Philippines rice is the principal article of food, and until the cultivation of sugar and hemp was shown to be more profitable, the cultivation of rice was the chief industry of the people. It was formerly an export, but is now an import. The amount imported during the year ending June 30, 1916, was about 400,000,000

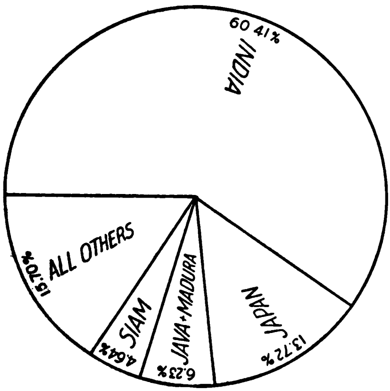

FIG. 78

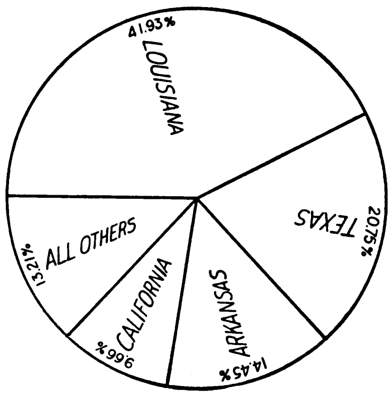

FIG. 79

FIG. 78.—World's production of rice. Percentages by countries. 1912-1916 inclusive.
FIG. 79.—Production of rice in the United States. Percentages by states. 1914-1918 inclusive.

pounds, the value of which was roughly $6,000,000. In addition to the more profitable cultivation of hemp and sugar mentioned above, the increased importation of rice has been made necessary by the death of large numbers of carabao, due to the rinderpest. The work of locusts and the prevalence of cholera have aided in decreasing the yield.

Buckwheat.—Because the seeds of buckwheat resemble those of other grains, it is generally classed as a cereal, although it belongs to the dock family. The seed, which is black, resembles somewhat in its triangular shape that of the beechnut. It was probably on this account that the Germans gave it the name of buchweizen (beechwheat).

For centuries buckwheat has been grown in central Asia, around the Caspian Sea, and in the basin of the Volga. By some it is believed that it was taken into Europe and Asia by the Tartars. The fact that buckwheat requires a relatively short growing season is taken advantage of in southeastern Europe, where the land is often planted to this crop after an earlier one has been harvested. Since it can be sown very late and yet ripen before danger of frost, it is adapted to upland regions and to those of high latitudes.

In the United States 1,000,000 acres were sown to buckwheat in 1918. More than one-half of the total acreage was in three states, namely, Pennsylvania, New York and Michigan, and more than three-fourths of the total yield was obtained from the same source. Russia, France and Japan grow large amounts of buckwheat.

Buckwheat is fed to horses, cattle and poultry. In some parts of the United States it is sown solely for the benefit of honey-bees. Buckwheat honey is rich but dark in color. To some extent the grain enters into the manufacture of bread, and in the United States buckwheat griddle cakes are very popular, especially during the winter. As buckwheat contains about 10 per cent. of gluten and 52 per cent. of starch, it is quite valuable as a food.

STUDIES

Is corn an important crop in your state? What is the average yield per acre? How many barrels of flour could have been made from the wheat grown in your state last year? For how long will the United States continue to be a wheat-exporting nation? What inventions have been of great value to the corn and wheat grower? In what countries is rice the staple food? Do we need to conserve wheat in times of peace?

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CHAPTER XIX

The Fiber Plants

COTTON

Description.—How early man began to use the fiber of the cotton plant is not known, but it is mentioned by Herodotus, 445 B.C. Cotton generally grows to a height of from two to four feet. There are in our country two main varieties, the "upland" and the "sea island." The former, as the name indicates, is grown on the relatively high land, while the latter is grown on islands and close to the coast, chiefly between the latitudes of Savannah and Charleston.

Each plant produces many bolls, and when these open the cotton is gathered. Picking is generally done by hand, although picking machines are used.

The fiber of the sea-island cotton is about two inches in length. This leads to its use in the making of thread, lace and fine cambrics. The Egyptian cotton, having a long staple, is imported by the United States to some extent. This cotton is being grown under irrigation in southeastern California and in the Salt River valley of Arizona. If this can be done on a large scale, it will mean much to this section of our country, and may lead to the manufacture of cotton goods on the Pacific Coast. Upland cotton has a short staple. It is used extensively in the manufacture of ordinary cotton goods.

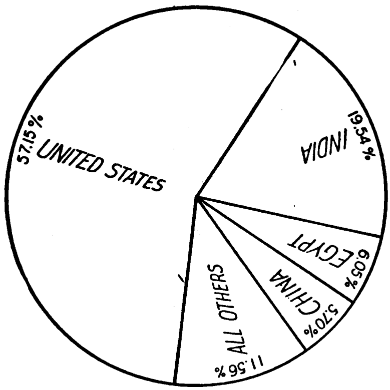

Fig. 80.—World's production of cotton. Percentages by countries. 1914-1917 inclusive.

Distribution.—Of the world's output of cotton more than one-half is grown within the United States. In 1918 our country produced about 11,000,000 bales, valued at approximately $1,500,000,000. This abnormal value was due to war demands. Texas, Georgia, Mississippi, Alabama, the Carolinas and Arkansas are the great cotton states. The deep, rich soils of the cotton belt are the result of the disintegration of the underlying limestone rock. In this belt the negro population is, of course, very large.

TABLE 9.

AVERAGE ANNUAL YIELD OF COTTON, 1909-1913 INCLUSIVE.[1]

Countries	Bales (round numbers)	Rank
United States	13,000,000	1
British India	3,500,000	2
Egypt	1,445,000	3
China	1,200,000 (estimated)	4
Russia (Asiatic)	639,000	5
Brazil	271,000	6
World	22,250,000	

In the United States the average yield per acre for the decade ending in 1915 was 186 pounds, and the average farm value was 11 cents per pound. In 1910 the average yield was but 170 pounds per acre, but in 1914 it rose to 209, which is the highest on record.

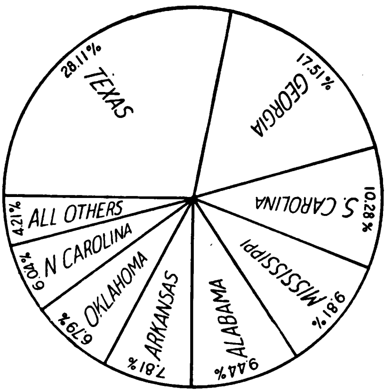

FIG. 81.—Production of cotton in the United States. Percentages by states. 1914-1918 inclusive.

Cultivation and Preparation.—Planting in the United States occurs from the middle of March to the middle of May, and harvest begins about September first.

Ginning the cotton, or separating the seeds from the fiber, was, until the invention of the cotton gin by Eli Whitney in 1793, a very slow process. This work furnished employment to large numbers of colored people. It is said that an average workman would gin only about one pound of fiber per day. Whitney's invention, therefore, revolutionized the cotton industry.

Gins differ somewhat. In some, steel discs having notched edges catch the fibers and pull them away from the seed. The fiber is then blown through tubes to a press, where it is baled. In the United States the average weight of a bale is about 500 pounds.

Shipment.—From the fields the bulk of our cotton crop goes to seaports to be shipped to New England or Great Britain. The larger part of that which goes to Great Britain is manufactured in the Manchester district. Liverpool and Manchester regulate the

[1] "Yearbooks, U. S. Dept. of Agriculture."

price paid for raw cotton. We also export considerable cotton to Bremen, Havre, Genoa and Trieste.

Galveston receives the crop of Texas, and the crop is earlier than that in the other states. The Mississippi is the natural channel down which a large part of the crop in its basin finds its way to New Orleans. On the southeastern coast, Savannah and Charleston are the chief cotton ports. The cost of transporting cotton from the fields of the South to the seaports averages 56 cents per hundred

FIG. 82.—Cotton picking.

pounds, and from the seaports to the markets in the United Kingdom 32 cents per hundred. Thus at a cost of less than one cent per pound American cotton is delivered to the great cotton mills in the British Isles.

Manufacturing Centers.—New England has always been the center of the cotton manufacturing industry in our country. She has the natural advantages of good harbors, abundant water-power and proximity to coal fields. A cotton mill was established at Beverly, Massachusetts, in 1787, one at Providence, Rhode Island, the next year, and one at Pawtucket in 1790. Lawrence, Lowell, Manchester and Nashua, cotton manufacturing centers, are situated on the

Merrimac. In Maine we have Lewiston on the Androscoggin; on the Kennebec, Augusta and Waterville, and on the Saco, Biddeford. Fall River and Woonsocket are two of a group of cotton centers at the head of Naragansett Bay.

The marvelous development of the South is threatening in time to wrest from New England the great industry of cotton manufacturing. Already the South has a larger number of mills than has New England, but their output is not so great. In the South are

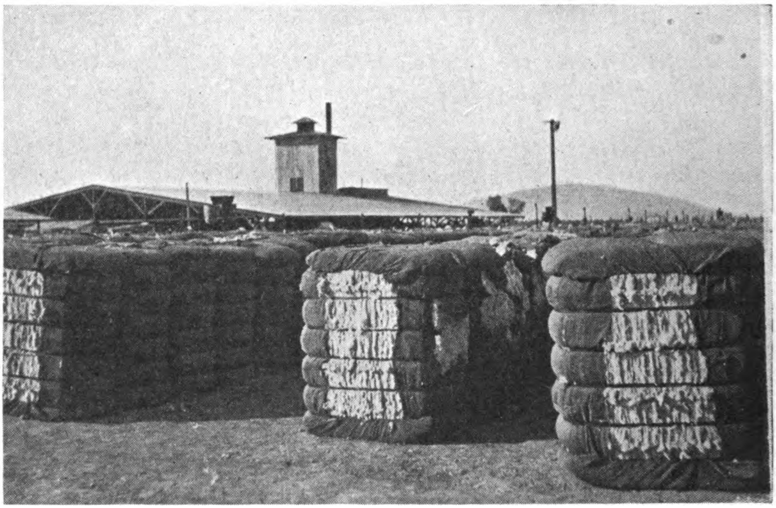

Photo by Kathleen Beck.

FIG. 83.—Cotton awaiting shipment.

coal, water-power, the raw cotton, and the advantages of a short haul. All along the Fall Line are cities where, owing to the presence of power, manufacturing is developing rapidly. Such are Macon, Columbia and Raleigh. Long experience and the resulting skilled labor are in a measure lacking, but this will be remedied in time, for skilled workmen are going into the South, and education is preparing them at home.

The establishment and the operation of mills in the cotton belt means great changes in other economic lines. It means the expenditure of large sums of money, the employment of various kinds of labor, and the development of many other industries.

At the mill the cotton bales are opened by machinery and the fibers pulled apart. After the dirt and leaves have been removed the cotton is "carded" by being passed between rollers having steel points which arrange the fibers so that they lie parallel. After the fibers have been loosely twisted and wound on spools a "mule jenny" spins it into thread or yarn. The yarn is then, by means of power looms, converted into cloth such as cheese-cloth, muslin, duck, cambric and other kinds. By printing designs upon them, plain cotton goods are changed into calicoes.

Practically every part of the cotton plant is utilized. The seeds on being pressed yield from 15 to 20 per cent. of oil. By adding a

FIG. 84.—Baling cotton.

little caustic acid to the oil it is purified so that it can be used in cooking. It is used extensively as an adulterant for olive oil, and in the making of soap and candles.

The material left when the oil has been pressed out is in the form of sheets called oil-cake. This, when ground up, makes good cattle feed. The hulls and the stalks of the cotton plant are used in the manufacture of paper and as fuel.

Like other crops, the cotton has its enemies. Tremendous loss has resulted from the work of an insect called the boll weevil. The eggs are laid in the bolls, and the larvæ eat and destroy the cotton. As a result of experimentation carried on by our Department of Agriculture, it has been found that by burning the plants in the fall and planting the seeds early in the season much loss can be avoided. The burning of the plants destroys untold numbers of the insects. The farm on which the experimental work was done yielded about three times as much cotton per acre as did a check-farm (a farm where the experimental work was not done) several miles distant, although the soil on the check-farm was more fertile. This work resulted in a gain of about $20.00 per acre.

Improved machinery and methods have greatly lessened the cost of cotton goods, and brought about a consequent increase in their

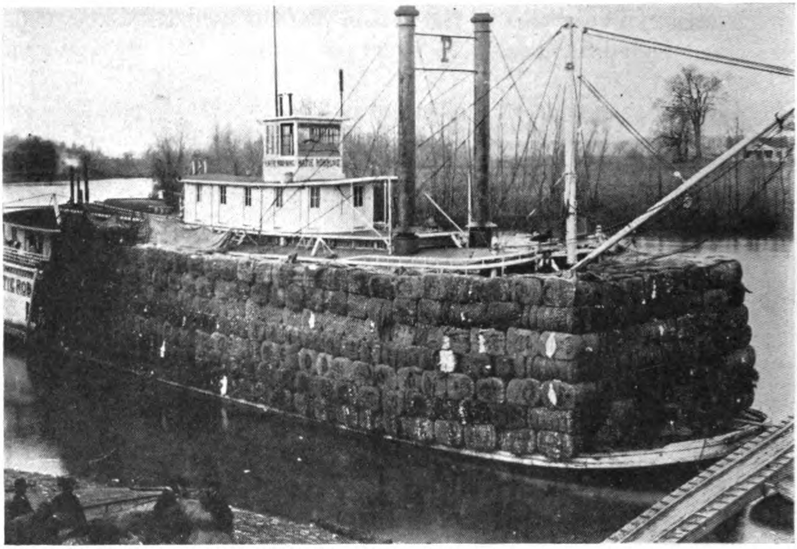

FIG. 85.—River steamboat loaded with baled cotton.

use. We now sell large quantities of cotton cloth to China. Most of it goes to Shanghai, from which point it is distributed to various parts of the populous Yangtse valley.

FLAX

History.—It seems almost like the work of magic to convert the fiber of a simple little plant into beautiful wearing apparel, or into costly laces. The period of human progress must have been measured by many centuries before this was realized, yet flax was used by the Babylonians, Chaldeans, Phœnicians and Egyptians thousands of years ago. During the Stone Age of Europe the Swiss Lake Dwellers manufactured linen cloth.

Flax is believed to have originated between the Caspian Sea and the Persian Gulf, but a knowledge of its value gave it a wide range. In 1630 it was introduced into Massachusetts, and during colonial days the raising of flax and the manufacture of linen were industries in which nearly all rural families participated. The invention of the cotton gin in 1793 made possible the manufacture of cotton cloth at so low a price that the linen industry at once declined.

Description.—There are many varieties of flax, but the *Linum usitatissimum*, or "most useful flax," is the one commonly cultivated. The plant is an annual, reaching a height of two or three feet, and having a blue blossom. It is raised both for its seed and its fiber.

FIG. 86.—A flax field.

Distribution—While flax has a wide range, being found from the 10th to the 65th parallels of north latitude, it flourishes best where there are rather mild temperature conditions and an abundance of moisture. About one hundred days free from frost are required for the maturing of the crop. In the region about Green Bay, Wisconsin, where flax is successfully grown, the average temperature during the growing period is 54° F. At Belfast it is 52° F., and at Brussels 59° F. For the same period the humidity at Green Bay is 72 per cent., at Belfast about 85 per cent., and at Brussels 77 per cent. In Russia, where the crop has been cultivated for a long time, it has become adapted through selection to the short summers of the north and the dry climate of the south.

The crop has never been a permanent one in our country, but has been constantly shifted to new areas. It has been believed that flax quickly exhausted the soil. Recent studies seem to show that the difficulty is due to a fungus growth. This can be overcome by careful selection and treatment of seed.

TABLE 10.

AVERAGE ANNUAL PRODUCTION OF FLAX FIBER, 1910-1912 INCLUSIVE.[2]

Country	Pounds (round numbers)	Rank
Russia (European)	866,577,000	1
Belgium	55,333,000	2
Austria	49,456,000	3
France	41,398,000	4
Ireland	24,728,000	5
Netherlands	18,778,000	6

TABLE 11.

AVERAGE ANNUAL PRODUCTION OF FLAX SEED, 1912-1914 INCLUSIVE.[3]

Country	Bushels (round numbers)	Rank
Argentina	35,000,000	1
Russia (European)	23,299,000	2
India	20,898,000	3
United States	19,891,000	4
Canada	16,948,000	5

Flax requires a well-drained but not a particularly fertile soil. If there be too much clay the straw is long, but does not yield the best quality of fiber. A large part of the world's supply of flax comes from Russia, but Belgium produces the best fiber. Ireland, Holland, Austria, Hungary, Italy, France, Canada and the United States and Argentina are other flax-growing countries. The Dakotas, Montana and Minnesota produce practically all of the flax grown in our country. In southern Russia, India, Argentina and the United States the plant is cultivated almost entirely for its seed. The yield of seed in the United States increased from 562,000 bushels in 1849 to 29,285,000 bushels in 1902. In 1916 the yield was 14,000,000 bushels. Near Yale, Michigan, Northfield and Huron Lake, Minnesota, Salem, Oregon, and in the Puget Sound country, some fiber is produced. The yield of seed in Canada has increased very greatly, Saskatchewan being the chief producing area.

Cultivation.—In preparing the ground for flax, deep ploughing and thorough pulverizing are very essential. The seed are sown broadcast. Successive crops of flax cannot profitably be grown upon the same land. In some countries the same fields are planted but once in eight or ten years.

Weeds are the bane of a flax-grower. It is necessary carefully to

[2] "Yearbook U. S. Dept. of Agriculture, 1913," pp. 432, 433.

[3] "Yearbook U. S. Dept. of Agriculture, 1916," pp. 479, 480.

weed the crop, and as this must be done by hand it adds much to the cost of production. The weeding takes place when the plants are one to two inches in height.

When the leaves are just beginning to turn yellow, and the seed is in the dough, the flax is harvested by being pulled by hand. If the crop were cut, the escape of moisture from the stems would discolor the straw. The flax is next set up in little bundles to dry, after which it is *rippled.*

If the seeds are to be saved, the bundles are, after having been cured, held heads foremost against rollers of corrugated iron by means of which the seed-pods are crushed. The leaves and seed are separated by a fanning mill, and the straw is then stacked.

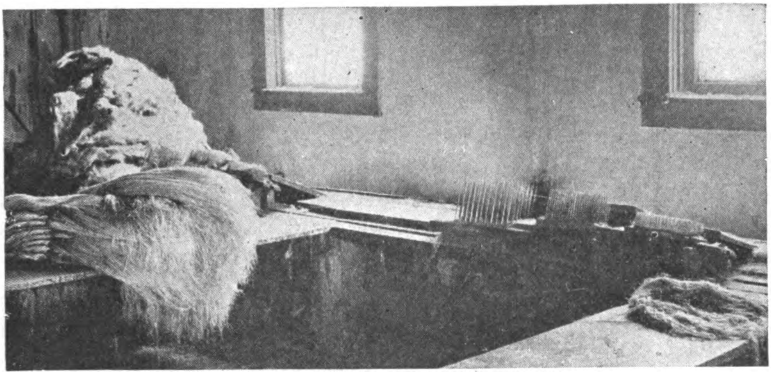

FIG. 87.—Flax hackles. Dressed or hackled flax is prepared by drawing the scutched fiber first over the coarse hackle, then over the finer ones, combing out shives and coarse and tangled fibers. (U. S. D. A.)

Retting is a partial decay of the outer part of the stem. This process may take place on the ground where the plant is exposed to the dews and rains, or in ponds, streams or tanks. The quality of the linen depends, in large measure, upon the retting of the flax. Although dew-retting produces the most unsatisfactory results, it is the process most commonly employed in our country. In Ireland pond-retting is generally practiced, while in Belgium, where the best fiber is produced, stream-retting is employed.

The Courtrai flax, which takes its name from a town in western Belgium, is of a light, creamy color, and possesses great tensile strength. This celebrated flax is retted in the river Lys, a sluggish stream believed to possess peculiar properties for this work. The bundles of flax are placed on end in crates about twelve feet square and three feet high. These crates are tight on the bottom, but are open on the sides. Before loading the crates, canvas is spread on the bottom and allowed to cover the sides. When the loaded crate is submerged in the stream the canvas keeps out the dirt. The flax remains in the stream from four to fifteen days, according to the temperature of the air and water. It is then spread upon the ground to dry, after which it is immersed for a second period about equal to the first.

Tank-retting avoids the pollution of the waters of the streams. The tanks used are made of brick or wood, the bundles of flax being placed in them endwise. Water enters through an intake, and is carried off at just the right moment.

The woody fiber of the flax is loosened by a process called *breaking*, after which all waste material is removed by *scutching*. The fiber is now *hackled* or *combed*. This straightens the twisted fibers and takes out the broken ones.

Manufacture.—Belfast has long been known for its manufacture of fine linens and laces. Lille, France, is also very important in this line. There are three natural causes for this: the nearness of the raw material, the proximity of the coal fields, and the short distance of the city from the river Lys, to which the peasants carry their flax to be retted.

Products.—From flax fiber linen carpet-yarns, linen thread for shoe-making, twines, toweling, cables, linens and laces are made. The finest of paper is made from linen rags, while flax seed is used in making oil-cake and linseed oil, the latter being employed in the manufacture of paints.

It is seen from this that several industries center about flax-producing areas. In the United States we have at least two mills for the manufacture of binder-twine from the fiber—one in Minnesota and one in Michigan. We have some forty mills for the crushing of the seed, the most important located at Buffalo, Minneapolis, New York and Chicago. Most of the oil is used at home, but we export considerable oil cake to Europe. Vast quantities of straw, which might be used for fiber, are burned yearly in our country. Our Bureau of Plant Industry is making exhaustive studies, hoping to be able to develop the culture of flax as a permanent and profitable feature of our agriculture.

In 1918 the average price of flax seed per bushel in the United States was $3.40. The average yield per acre for the same period was 8 bushels.

HEMP

History.—Hemp was probably the first plant cultivated for fiber. It is believed that its original home was China. According to an ancient Chinese record, the plant was in use as early as the 28th century B.C. Hemp found its way into Europe many centuries

FIG. 88.—Cutting hemp by hand. (U. S. D. A.)

before the beginning of the Christian era, and it was carried to New England soon after the first settlement was established.

Description.—The hemp plant is an annual, growing from five to fifteen feet in height, and with stems about as thick as a man's finger. The leaves are of a rich, dark green color. The fiber is long, soft and strong, but as it cannot be bleached white it is not used in the manufacture of fine fabrics.

Cultivation.—Hemp thrives on fertile soils like those of bottom lands. It requires from 80 to 100 days for its maturing. Hemp does best in a rather humid climate, and it requires four months free from frost. A temperature varying from 60°-80° F. is the most desirable. In Kentucky much of the crop is pulled by hand, but in the Western States most of the work is done by machinery. A good workman may cut one-half acre per day, while with a machine from five to ten acres can be cut daily.

After cutting, the unbound bundles are left on the ground for some time to dry. Finally they are placed in the stack, where they are allowed to remain for two or three years. This is said to improve the quality of the fiber and to make the breaking and cleaning easier. The great desire of the grower is to obtain a uniform stand of stalks, for unless this can be done a good yield of fiber cannot be expected.

Distribution.—Russia produces more hemp than all other countries of the world combined. She manufactures large quantities, and exports some raw material. Hemp thrives in Italy, France, Hungary, Germany, Algeria and in the warmer parts of Asia. In our country, Kentucky, Illinois, Nebraska, Texas and California produce considerable fiber. In nine counties of the famous "Blue Grass" region of Kentucky more than three-fourths of the American product is grown.

Like flax, hemp must be retted. This is done in a variety of ways. In Kentucky the stalks are placed upon the ground in November and allowed to remain until the vegetable gums that surround the fiber have been destroyed. After retting, the stalks are handled by the breaker. This work is sometimes done by hand, and sometimes by machinery.

Uses.—Hemp is used in making sackcloth, binder-twine, seine twine, homespun, threads and yarns for carpets, and towels. The refuse fiber is combed from the tow and used as oakum in calking vessels. The oil pressed from the seeds is used in making soap and paint. About 1,000 pounds of rough fiber are produced from an acre of ground. The price which the grower receives varies from three and one-fourth to five cents per pound. The United States consumes annually about 18,000,000 pounds of hemp, and of this total we produce only about 9,000,000 pounds.

JUTE

Practically all of the world's supply of jute comes from the province of Bengal in India. Jute is raised also in southern China and Formosa. It is produced from the inner bark of two plants which resemble hemp, although they are not related to it. The fiber is long, soft and glossy, but as it has comparatively little strength it is not used in the manufacture of fine textiles. Gunny-sacks, burlap, twine, rope, carpets and upholstery are made from jute.

The jute mills in Bengal employ more than 100,000 persons Large quantities of gunny-cloth and gunny-sacking are exported to the United States, Chile, Australia and other countries where grain sacks are used extensively. Jute is also manufactured into burlap, and is used to cover cotton bales.

ABACÁ OR MANILA HEMP

By all odds the most valuable export of the Philippine Islands is abacá. During the last half century the value of the raw product has increased from about $4,500,000 to some $50,000,000 annually. In 1918 the value of the hemp exported from the Philippines equaled about fifty per cent. of the total value of all exports. More than one-half of this was sent to the United States.

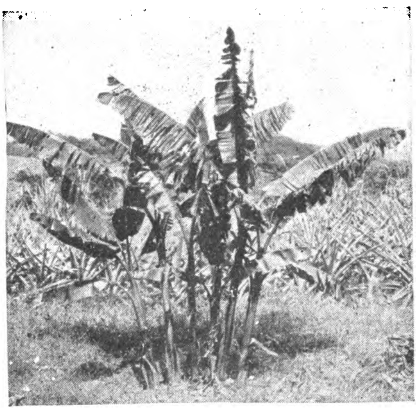

FIG. 89.—Abacá (Manila hemp) injured by wind. (U. S. D. A.)

The trees from which the fiber is obtained (*Musa textilis*) do not belong to the hemp but to the plantain family, and very closely resemble the ordinary banana trees. The plants bear no edible fruit, however.

Nothing is known of the origin of the tree. It is probably a native of the Philippine Islands, as it will thrive nowhere else. On this account the islands have a monopoly of the Manila hemp industry. The northern part of Luzon is the chief center.

Plantations are started either by planting seed or suckers. The planting is done during one of the rainy seasons, that is, between May and July, or September and November. Plants started from suckers mature about six months earlier than do those started from seed. The suckers are planted in rows from five to eight feet apart. For a time protection from the hot sunshine and violent winds must be afforded the young plants. This is secured by leaving an occasional tree if the land is being cleared, or by planting a few trees for that purpose.

Soil having a high degree of fertility, and well drained, is necessary. Although the plants require much moisture, they do not thrive in a marshy soil. High relative humidity is especially desirable. As no animals are needed in the cultivation and harvesting of this crop, it reduces the expenses very greatly.

FIG. 90.—Weighing hemp upon delivery at Manila.

Within from three to four years after planting, the crop is ready to harvest. The trees are cut as close to the ground as possible, and as they renew themselves by means of suckers, the cutting is repeated every six or eight months.

To obtain the fiber the leaf-sheaves are split into strips two or three inches in width, and these are drawn between the edge of a knife and a block of hard wood. This scrapes off the pulp. Knives having teeth do the work more rapidly than do the smooth ones, but they injure the fiber. It is estimated that the loss resulting from the use of crude appliances is from 20 to 30 per cent., yet for the most part there is little improvement in methods or tools.

After the pulp has been scraped from the fibers the latter are hung across poles to dry for a few hours. They are then loosely packed in bundles. Before being shipped the bundles are opened, the fiber is given a second drying, and is then baled.

There are three grades of commercial fiber, "current," "second," and "colored." The current, which commands a higher price than the others, is light yellow in color and has a silken luster. Practically all of the Manila hemp exported goes to the United States and Europe to be made into cordage, rope and twine for the binding of grain. The chief use of the fiber in the United States is in the binding of grain. To bind an acre of wheat or oats about two pounds are required. Good commercial fiber is about six feet in length.

The hemp used for domestic purposes is employed in the manufacture of a cloth known as sinanay. A beautiful cloth called lupis is made from the finest of the fiber. Sometimes silk and the fiber of the pineapple leaf are mixed with the hemp. Other articles made from the hemp are mats and hats.

HENEQUEN

Several varieties of the henequen, or agava, are found in Mexico. On the table lands grow the *Agava Americana*, from which pulque is made. This much-used Mexican beverage is brought into the capital daily on pulque trains. In Yucatan the *Agava sisalensis* grows both wild and cultivated. This, the henequen of commerce, is a plant having thick leathery leaves from three to four feet in length, and armed on the edges and at the tip with thorns.

The fiber of this plant, which is often called *sisal* hemp, because it first reached the outside world through the town of the same name, has been used in Mexico for many centuries. It has been an important factor in the commerce of Mexico for a comparatively short time, however.

Toward the close of the eighteenth century, Spain had some difficulty in supplying her navy with cordage, as the quantity of abacá obtained from the Philippine Islands was not sufficient for the demand. It was reported that Yucatan produced a valuable fiber, and a commission was appointed to investigate. This commission made a favorable report in 1783, and for some years henequen was exported to Europe. The decline of Spanish commerce put an end to this.

The poverty of the people of Yucatan finally led them to once more turn to the agava plant as a possible source of revenue. A few bales of the fiber were prepared and sent to New York, where they had a ready sale, but at a price so low as to leave little profit to the producer. To encourage the industry the government offered a prize of $10,000 for a machine that would clean a stated amount of fiber per hour. A Franciscan friar won the prize by producing the "raspador." With this machine two men could do as much work in a given time as forty had been able to do before. This gave a great impetus to the cultivation of the plant. While there are now some half dozen kinds of fiber-cleaning machines, many of the natives still use the primitive tool called the *pacchi.*

A thin, rocky limestone soil is said to produce a fiber of the greatest tensile strength, although a richer soil grows longer and more flexible fiber. The plant grows best in a belt about twelve miles from the coast and some seventy miles in width. It may be propagated by seed, cuttings or suckers. The third method is the common practice. The suckers are planted just before the rainy season in rows about eight feet apart, while the plants in each row are separated by a distance of four feet.

The plant needs little care beyond weeding. It is drought-resistant, but fire is its great enemy. A black beetle also does some damage. In about five years after planting, the earlier leaves begin to extend themselves at right angles to the plant. The fiber has then reached its greatest tensile strength and is ready to cut.

With long knives called *corbas* workmen sever the leaves from the plant, trim off the thorns and bind the leaves in bundles. Tramcars then haul them to the cleaning machine. Here rapidly revolving wheels set with knives tear the pulp from the fiber. The pulp is washed away by water running through the machine. The fiber is next taken to the drying grounds, where it is bleached in the sun for two or three days, after which it is baled under great pressure.

The fiber, which is three to four feet long, is white in color and constitutes about four per cent. of the leaf. There is much difference in the quality of the fiber, and growers are striving for improvement. Some plants will continue to produce for twenty years, while some cease production at the end of six or eight years. The end of the productive period is brought about by the blossoming of the plant.

Henequen is used in the manufacture of sacking, cordage, and binder's twine. In Mexico it is used in making mats and hammocks. In making the finest grade of hammocks the native will use only the hand-cleaned fiber.

The growing of henequen is assuming considerable importance in the Bahama Islands, Cuba and Hawaii, although the industry is chiefly centered in Yucatan. Progreso and Campeche are the great exporting centers, and most of the product goes to the United States. This fiber constitutes about 16 per cent. of the exports of Mexico, and is surpassed by silver only.

STUDIES

What countries would be seriously affected by a partial failure of the cotton crop in the United States? Is there any reason for believing that the manufacture of cotton goods in the United States will be entirely shifted to the South? Locate the European centers where linen is extensively manufactured. Why can not we successfully compete with European countries in the manufacture of linen? Why do we import so much Manila hemp and henequen?

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CHAPTER XX

Beverage Plants

COFFEE

Coffee is in no sense a necessity, and yet the United States spends roughly $75,000,000 annually for this commodity. We are the greatest consumers of coffee in the world, and most of our supply as well as that of the rest of the world comes from the state of Sao Paulo, in Brazil. Central America, Mexico, the West Indies, the Hawaiian, the Philippine and the East Indian Islands, Ceylon and Arabia are other coffee-producing regions. Since coffee is a native of the Far East, the fact that Brazil is now the chief producer is an interesting one.

Coffee growing is the one great industry on the rich red soils found in the state of Sao Paulo. There are approximately 700,000,000 coffee trees in the state. The coffee industry has led to a rapid increase in population, to building of railroads, to harbor improvements, and incidentally to development in many other lines.

Regarding the influence of coffee upon the growth of Sao Paulo, Bryce says: "Since 1875 the planting of enormous tracts of land with coffee has rapidly raised the wealth of the region, and this city, being its heart and center, has risen in sixty years from a small country town to be a place of four hundred thousand inhabitants."[1]

For the successful growing of coffee a high temperature and abundant rainfall are required. In Brazil coffee growing is most successful at the altitude of about 2,000 feet. When young, the plants need some shade.

In its natural state the coffee-producing area of Brazil is forested. Therefore the first step in establishing a coffee plantation is the clearing of the land. Usually the plants are started in nurseries. When transplanted they are set out in rows about 14 feet apart each way. A full crop is not obtained until the trees are about six years old.

The picking is done by hand, the fruit or *coffee berries*, being stripped from the branches. As the trees are usually kept pruned down to a height of eight to ten feet, most of the work can be done without the use of ladders.

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[1]Bryce, James: "South America," p. 375.

In Brazil the harvest season is from May to September. During this period very little rain falls, and therefore the drying of the coffee is facilitated. The laborers are Portuguese. They live in their own quarters on the plantations, or *fazendas*. Men, women and children take part in the picking. Many of the fazendas are so extensive that the workers carry luncheon with them.

Photo by C. C. Pierce.

FIG. 91.—A coffee plantation.

Usually two coffee *beans*, with their flat sides together, are enclosed by the pulp of the berry. The pulp may be removed by soaking the berries in water or by hulling. Generally the first, known as the *wet* method, is employed.

The drying of the beans takes place in the open air on floors of brick or tile. As the taste of the beverage depends, in large measure, upon the drying process, the coffee is very carefully watched by the superintendent. It is stirred at frequent intervals, and each evening raked up in piles, and sometimes covered as a protection against dew. Under certain conditions the beans may dry sufficiently in a few hours, but the process usually requires several days.

Each coffee bean is surrounded by two membranes, which must be removed before the coffee is ready for the market. This is done in a hulling machine, which on the larger plantations is operated by machinery. Following the hulling, the beans are winnowed, to remove dirt and broken hulls, sorted and put up in sacks containing 132 pounds each.

Coffee exhausts the soil after several years of cropping, and land which no longer yields a crop is by some planters left to revert to a forest condition. "Many of the coffee plantations of forty or even thirty years ago have been abandoned, and their sites are now practically indistinguishable from the rest of the forest."[2]

Santos is the natural outlet for the coffee of the state of Sào Paulo. "In Santos coffee absolutely dominates the lives of the people. Coffee is everywhere—on the streets, in the warehouses, on the trains. Every one is busy with coffee. The docks are lined, two or three miles of steamers, often lying two abreast, all waiting to load coffee—a wonderful sight—steamers flying the British flag, and the German flag, and the French flag, and the Brazilian flag—steamers flying almost every known flag except our own glorious Stars and Stripes.[3] Here in Santos, in the big warehouses lighted from above, the coffee dealers carefully blend and repack the precious berries. Here the holds of the waiting steamers are filled almost to the bursting point with the well-known flat bags of coffee. Here the traveler sees the last step in the progress of the coffee berry, from the time it ripens on the tree until it leaves Brazilian soil, to furnish some breakfast table in a far-off land with the favorite morning beverage of the civilized world."[4]

TEA

Among the important commodities which we obtain from the Orient is tea. The tea plant has been grown in China for many centuries, but tea was used as a medicine until 550 A.D. In 1657 a tea house was established in London. Until 1837 China had a monopoly practically of the tea trade of the world, but today India, Ceylon, Formosa, Japan and the Dutch East Indies are important producers.

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[2]Bryce, James: "South America," p. 390.

[3]The reference to our flag no longer holds true. Today the Stars and Stripes fly in every great harbor of the world, for one result of the World War was the expansion of our merchant marine.

[4]Ward, Robert DeC.: *National Geographic Magazine*, vol. xxii, p. 931.

The plants are propagated in nurseries and transplanted to the tea farms. A crop can be gathered in from three to four years after transplanting. The life of the plant is about 25 years.

The plant is an evergreen which, because of frequent pruning, is kept down to a height varying from three to six feet. Under natural conditions the tree would reach the height of twenty-five feet. The pruning insures a better quality of tea, and makes the picking of

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FIG. 92.—Picking tea.

the leaves less expensive. The blossoms are fragrant, and white or rose-colored.

Climatic Conditions.—The tea plant requires a tropical or subtropical climate, and about 50 inches of rainfall per annum. More than one-half of this total should fall during the growing season.

Picking and Preparation.—The leaves are picked by hand, and there are several pickings each season. In the tea sheds the leaves are placed on bamboo mats or trays and turned at short intervals until they are slightly wilted. Next they are roasted or "fired" in metal pans or kettles over charcoal fires. This causes the leaves to soften, and they are then placed on tables and rolled by hand. After this they are given a second roasting. Of course there are many modifications of the process.

For a long time it was supposed that green and black teas came from different plants, but this is now known not to be the case. If black tea is desired; it is left exposed to the air until oxidation occurs.

Formerly tea was adulterated to a great extent, but this is not so common at the present time. Prussian blue, indigo, turmeric, soapstone and the leaves of certain plants are used as adulterants. In China, tea is largely prepared by hand, and consequently many object to it. India and Ceylon teas are handled by machinery, and are therefore more sanitary.

Tea-growing in the United States.—About 100 years ago a French botanist, Michaux by name, planted some tea in the United States on the Ashley River, some 15 miles from Charleston, South Carolina. In 1848 Dr. Junius Smith undertook the growing of tea near Greenville, in the same state. Ten years later Robert Fortune was sent by our government to China to study the tea industry.

As a result of these beginnings there is located near Summerville, South Carolina, the "Pinehurst" tea gardens, consisting of about 100 acres. The annual output now amounts to from 14,000 to 16,000 pounds. This finds a ready market at high prices.

Trade.—China's tea trade, although still enormous, has fallen off in recent years. Great quantities of tea are pressed into bricks at Hankow and sent on camel back to Russia, which is China's best customer in the tea trade. Not all of the tea sent from China to Russia goes overland, as much is sent by ship to Odessa.

The people of the United Kingdom use more tea per capita than do the people of any other country except Australia. The average amount imported by the British Isles for the years 1910 to 1915 inclusive was, in round numbers, 300,000,000 pounds. For the years 1913 to 1918 inclusive, the average annual importation of tea into the United States amounted to about 110,000,000 pounds, with an approximate value of $20,000,000. The United States is the world's greatest consumer of green tea.

COCOA

The production of the three great table beverages, coffee, tea and cocoa, is limited to the warmer parts of the world. Cocoa is a product of the cacao tree, which is extensively grown in Ecuador, Venezuela, Brazil, Mexico, the East Indies and Ceylon. The larger part of the world's supply comes from the Americas.

When first the Spaniards came to the New World they found the natives of Mexico and South America using a drink called by them "Chocolatl." In time the use of cocoa and chocolate was introduced by the Spanish explorers into their own country.

The cacao tree bears pods varying from six inches to a foot in length. They are pear-shaped, and somewhat fluted. When ripe they resemble cucumbers in appearance. Instead of being attached to the ends of the twigs, the pods grow directly from the trunks of

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FIG. 93.—Gathering cocoa pods.

the trees and larger branches. Within the pods are seeds, often as many as 50, about as large as almonds. It is from the seed that cocoa and chocolate are made.

When harvest time occurs, the pods are cut from the trees by workmen carrying poles to one end of which knives are attached. The pods are allowed to fall to the ground, where they usually remain for a day before being opened for the removal of the seed.

The seeds are dried on floors or platforms, much as is coffee. When thoroughly dried the seeds, which at first are white, are brick-red in color. They are shipped in sacks containing about 150 pounds each. Ecuadorian cocoa is exported from Guayaquil. La Guaira is the shipping point in Venezuela.

After the cocoa has reached its destination it is roasted. This develops the pleasant *aroma*. The next process is the grinding of the seed. From the resulting flour an oil substance called "cocoa butter" is separated. After the removal of the cocoa butter the flour is known as *cocoa,* before the removal of the cocoa butter it is *chocolate*. Chocolate in its natural state is bitter. Sweet chocolate is made by adding sugar to chocolate.

When in a pasty condition chocolate is run into moulds and allowed to cool. Cocoa is sold in the form of a flour or powder. As milk is extensively used in the manufacture of chocolate, this industry is important in countries where dairying is a leading industry. Holland, Switzerland and the United States are manufacturers of chocolate on a large scale. The city of Amsterdam, Holland, practically controls the price of the raw product.

In the year 1765 there was built at Dorchester, Massachusetts, on the Neponset River, the first cocoa and chocolate plant in what is now the United States. Today the establishment of the Baker Chocolate Company occupies this same site.

MATÉ

Unlike coffee, tea and cocoa, maté does not enter into the commerce of the world. It is used extensively in Paraguay, of which country the plant from which it is made is a native, and in Uruguay, Brazil and Argentine Republic. Paraguay produces some 18,000,000 pounds of maté annually, about one-half of which is consumed in that country.

Maté, which is also called Paraguayan tea, is made from the leaves of a species of the holly plant. The beverage contains caffeine, the same stimulating element found in tea and coffee.

The leaves are gathered during the dry season, and after being thoroughly dried, are crushed or beaten up into small pieces. The product is then shipped in sacks of about 200 pounds each.

When maté is to be served, some of the powdered material is placed in a gourd and hot water poured over it. The tea is drunk through a long tube called a *bombilla*. The lower end of the bombilla is enlarged and perforated. Thus the leaves are excluded from the tube.

So universal is the custom of drinking maté in the countries mentioned, that the gourd and the bombilla are generally passed whenever a family has callers.

STUDIES

Locate the chief coffee-producing areas. What is the per capita consumption of coffee in this country? Would it be possible for the United States to grow enough tea to meet the home demand? Discuss the labor conditions which apply to the tea industry. On a map of the world locate the cocoa-producing regions.

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CHAPTER XXI

Fruits

General Statement.—The term fruit, as used in botany and in ordinary conversation, has quite different meanings. In a botanical sense the term refers to that part of a plant which bears the seed. As the word fruit is generally employed, it applies to the crops of certain trees such as the apple, peach, cherry, orange, banana and many others.

Although fruits and berries are very largely used as articles of food, their actual nutritive value is not high. The acids and oils which they contain cause them to be palatable, and they aid in the process of digestion. Certain fruits, such as the fig and the prune, have a special value because of their laxative nature. Olives possess considerable food value, being about 15 per cent. oil.

Apples.—Of the common orchard fruits, the apple is the most important. It is believed to be a native of southwestern Asia. There are about 1,000 varieties of apples, all of which have been derived from two wild varieties. Apples are grown extensively in the British Isles, France, New Zealand, Canada and the United States.

The United States exports both fresh and dried apples in large quantities. The value of the apple crop in our country is more than one-half that of all fruits, and amounted in 1918 to about $200,000,000. The chief apple-growing states are: New York, Pennsylvania, Michigan and Missouri; New York being far in the lead.

The loss inflicted by the codling moth in the United States alone amounts to millions of dollars annually. It has been discovered that the downy woodpecker, by boring into the bark of trees, destroys large numbers of the larvæ, but spraying is resorted to as a more effective check.

Apples are peeled, cored and sliced by machinery, and dried by artificial heat. Better methods of storing fresh fruit are leading to a decrease in the quantity dried. Some apples are used in the manufacture of cider and vinegar, and in France much apple jelly is made.

Peaches.—Peaches are grown extensively in the United States, Canada, New Zealand and the Mediterranean countries. In our country, peaches rank next to apples in value. The chief producing states are: California, Georgia, Arkansas, New York, Michigan and Kentucky. The influence of the Great Lakes upon the peach industry is quite marked. In the lower peninsula of Michigan, in western

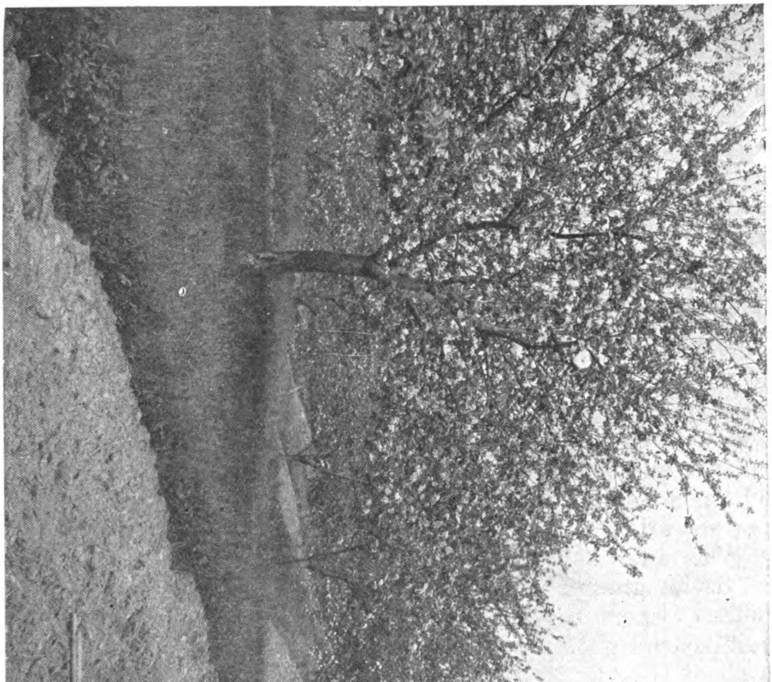

FIG. 94.—An apple orchard.

New York and in peninsular Canada the lakes check the advance of spring. Fruit trees therefore do not commonly blossom early enough to have the crop damaged by late frosts. West of the lakes, in the same latitude, the winds blow over a land area, which, warming quickly, starts the buds before the danger from spring frosts is over.

Peaches are both dried and canned in large quantities. The long, dry summers with high temperature which prevails in California are favorable to the drying of the fruit out of doors. In more humid regions the peaches are dried by artificial heat, which increases the cost. In 1918 the people of the United States produced 20,500,000 bushels of peaches.

In the drying process the first operation is the cutting of the peach into two equal parts and the removal of the stone. This is done by hand. The fruit is then placed upon shallow wooden trays, and these, piled one upon another, are placed in a fumigator. This is in effect a very large box, and is commonly made of heavy paper nailed to a light frame. In the fumigator a small quantity of sulphur is burned. This gives the peaches a golden appearance, and acts as a preservative.

After a few hours in the fumigator the trays are spread out upon the drying ground, where they remain for two or three days. The number of pounds of green fruit required to make a pound of dried fruit depends upon the degree of juiciness. From three to five pounds is about the average.

Prunes.—Although there are hundreds of varieties of plums, most of them have comparatively little commercial value. They must be used fresh or else canned, because they cannot be successfully dried without removing the pit. The small size of the fruit makes this operation expensive. The prune is a variety of the plum which dries sweet without the removal of the pit, and it therefore is of great value.

France, the Balkan States and the United States are the chief prune-producing areas of the world. The output of this country comes almost entirely from California and Oregon. California produces approximately one-half of the world's crop. Santa Clara County, California, is especially noted, and the city of San José is probably the world's greatest prune center.

After being picked the fruit is usually dipped in hot water or lye to soften the outer skin. Quite generally the skin is pricked by machinery. This allows the excess of water to evaporate readily and prevents fermentation. In California prunes are dried in the

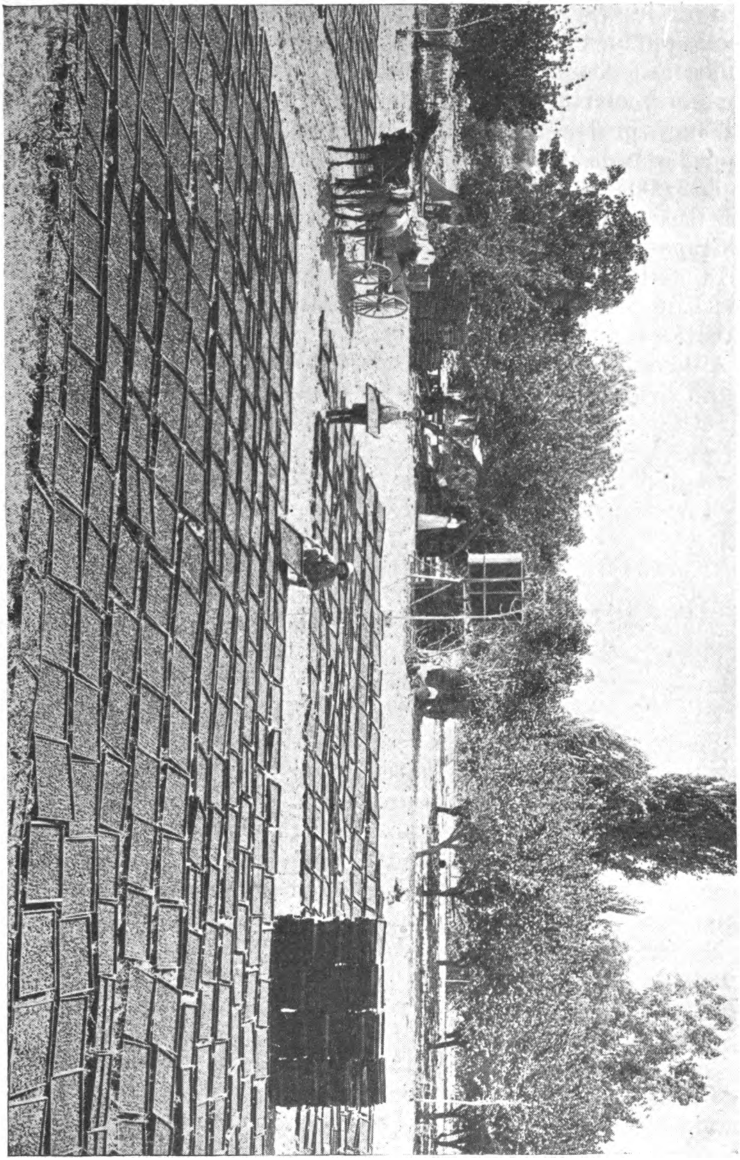

FIG. 95.—Drying peaches.

open air in trays about three by eight feet in dimensions. This process requires from three days to a week, depending upon weather conditions. After drying, the fruit is given a gloss by heating it in steam or immersing it in a fruit juice.

Fancy prunes are packed in boxes, but ordinary grades are shipped in bags and barrels. In 1887 the United States *imported* more than 92,000,000 pounds of prunes and plums. In 1918 we *exported* more than 30,000,000 pounds.

Grapes, Raisins, Wine.—Grapes are grown in many parts of the world, and in large cities are used in great quantities. They are of chief value, however, in their dried state (raisins and currants) and in the form of wine and brandy.

Although the grape has a wide range, the production of raisins is limited to a few areas. This is because a very dry climate is required for the curing of the fruit. There should be freedom from storms during the drying season. Spain, Asiatic Turkey and California produce the bulk of the world's supply of raisins. In our country the industry is practically confined to three counties of California—Fresno, Kings and Tulare. The first of these is the most important. The climatic conditions are practically ideal for the industry. Summer storms are of very rare occurrence, the temperature is high, the humidity low, and fogs seldom occur during the drying period.

Grapes are cut from the vines and dried upon trays. At the packing plant the raisins are stemmed and seeded by machinery, and a part of the work of packing is done in this way. Such grapes as the Muscat and Thompson's Seedless are the best for the production of raisins, because their skins are thin and their sugar content high.

In 1899 the United States produced 15,000,000 pounds of raisins, and in 1909, 195,000,000 pounds. We are now exporters, although certain kinds are imported, chiefly what are known as Zante "currants." Malaga is the exporting center of Spain.

Raisins have a high food value, as they contain 63 per cent. of carbohydrates, 5 per cent. of protein, and some fat. A pound of raisins is the equivalent of 4½ pounds of potatoes, 4 pounds of milk, 2 pounds of eggs, 1⅓ pounds of beef, or 1 pound of bread. Owing to this, and to convenience attaching to their transportation, their use in the army and by mountain climbers is increasing. In Great Britain 5 pounds of raisins per capita are consumed yearly; in the United States, 1½ pounds. In order to encourage their consumption at home a "raisin" day was established several years ago.

France, Italy and Spain are the great wine producers of the world. The United States, Argentina and Germany are less important. In some cases the grapes are hauled to the wineries in metal wagons, where they are unloaded onto cement platforms. Machinery conveys the grapes to the grinder. Here the stems and seeds are removed and the juice carried in pipes to vats and tanks, where the process is completed. The great casks into which the wine is finally run are labeled to show variety and date.

FIG. 96.—Drying seedless raisins in California. (U. S. D. A.)

For centuries the making of wine has been important in western Europe. The early settlers in America tried to introduce the European grape from which wine is made, but were unsuccessful because of a disease which attacked the vines. It was found that this variety of grape would flourish in California. This is the reason why the wine industry was important in California but not in the grape-growing sections in the eastern part of America. Excellent varieties of table grapes such as the Catawba were developed from the eastern native vines.

Citrus Fruits.—The orange, lemon, grapefruit (pomelo), lime, tangerine, kumquat and mandarin are citrus fruits. The three first named are the most important. Citrus fruits are semitropical products. The chief output comes from the Mediterranean countries, the West Indies, Mexico, southern California and Florida.

The production and marketing of these crops is expensive, and the cost of the nursery stock is high. Trees must in some areas be irrigated, and in some sprayed or fumigated to rid them of a pest known as *scale*, and much money is spent in guarding against frost.

Owing to cheap labor, low cost of living, and cheap water transportation in the countries mentioned other than our own, the citrus

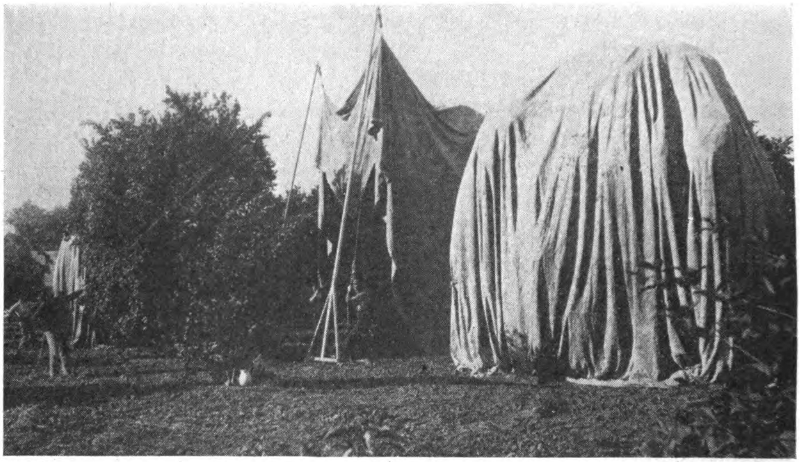

FIG. 97.—Fumigating orange trees.

fruit districts in the United States cannot, without a duty, successfully compete for our own markets.

Citrus fruits are very easily injured by frost. This is especially true of lemons. In both Florida and California the Weather Bureau Service is of very great value to growers. Special stations have been established, and warnings are sent out by telephone as well as in the ordinary way.

Owing to the fact that the winds blow directly from the ocean to California, it is not so subject to frost as is Florida. In the case of Florida, winter storms from the northwest occasionally move over it, causing great damage to the fruit. This was especially true in 1894-5, when the industry was nearly ruined. In 1912 California suffered tremendous loss on account of frost. Large sums of money are spent in smudging to prevent a fall in temperature to the danger point, and many growers have put in heating plants in which gas or oil is burned.

The United States produced in 1909 more than $22,000,000 worth of citrus fruits. The increase during the decade ending in that year was 231 per cent. The value of the oranges is about three times as great as that of the lemons and grapefruit combined. In the five-year period ending with 1908, California produced about 70 per cent. of our oranges and nearly all of our lemons.

Olives.—The olive tree is more resistant to frost than is the orange or lemon. It will endure a minimum temperature of about 14° F. The important olive-growing countries are: France, Portugal, Spain, Italy, Greece, Turkey, Algeria, Tunisia and California.

One of the advantages in connection with olive culture is found in the long life of the tree—often more than a century, and in some cases several centuries.

The ripe fruit of the olive tree, although very attractive, is not fit for food in its natural condition. This is because of its very bitter taste, probably due to the presence of certain gums or resins. These substances are removed by giving the olive repeated baths in water, or soaking it for a time in lye.

The olive is an excellent food because of the large percentage of oil that it contains, about 15 per cent. The oil is extracted for table use by crushing the fruit. A slight crushing yields the best quality of oil, and inferior grades are obtained by a second and third crushing. In the Mediterranean countries, where, owing to density of population and a dry season, cattle are not raised in large numbers, the olive takes the place of butter and meat.

Italy is probably the home of the olive tree, and Italy ranks first as a producer of olive oil. In Italy there are thousands of establishments where olive oil is produced. In many places the oil is extracted by very primitive means, and is of an inferior grade. Sicily and the region tributary to Naples are the most productive areas, for in southern Italy the climate is better adapted to olive-growing than is that of northern Italy.

The Spaniards introduced the olive into California in connection with the establishment of the chain of missions along the coast. Each one of these had its olive grove and its press for the production of oil. Practically all of the olives and olive oil produced in the United States come from California. In 1917 our country imported more than 7,000,000 gallons of olive oil for table use at a cost exceeding $1.35 per gallon.

Pineapples.—This fruit is very susceptible to frost, and does best where the mean annual temperature is from 75° to 80° F. It requires an open soil that permits free drainage. The chief pineapple areas are: Northern Africa, the Madeira, Canary, Azores, Bahama, West Indian and Hawaiian Islands and Florida. The plant is a native of America, and was discovered in South America by the Spanish explorers.

A pineapple plantation is called a "pinery," and picking the fruit

Fig. 98.—Where the pineapples grow. (U. S. D. A.)

is known as "breaking pines," because picking usually consists in breaking the stem, although some workmen use knives. When crated, the fruit is generally wrapped in papers.

Europe receives her supply of this fruit from northern Africa, Madeira, the Canary and the Azores Islands. The Bahamas, the West Indies and Florida supply the eastern markets in our country. Our Pacific Coast States depend upon the Hawaiian Islands. In 1909 Florida produced nearly 800,000 crates, valued at practically $1.00 per crate. Owing to the limited distribution of the pineapple, the price is high. Considerable quantities are canned in the Hawaiian Islands, and some of the fruit in its natural condition is shipped to San Francisco.

Bananas.—The banana is a tropical plant requiring a high temperature and much moisture. . The plant is not a tree in the ordinary sense of that term, but consists rather of one or several stalks from which leaves unroll. The leaves are from ten to fifteen feet in length, and usually present a ragged appearance because they are so easily torn by the wind.

Banana plantations are established by planting suckers about fifteen feet apart. Within a year after planting the suckers bear fruit. As new sprouts are constantly starting from the parent plant, the yield of fruit is practically continuous.

The large clusters of bananas that form the bunches are called *hands*, and the individual bananas *fingers*. A bunch consisting of nine or more hands is called a "first," while one of from seven to nine hands is called a "second." Buyers will seldom accept bunches containing less than six hands. A hand contains from ten to twenty bananas.

The fruit is cut when green, both because it is bruised so easily, and because it does not ripen well on the plant. If it were not for the fact that the banana ripens well after being cut from the plant it would have little commercial value. The stalks are cut at the same time, as they are of no value after having borne their crop, which may be from one to three bunches each. A bunch weighs from 50 to 60 pounds. The fruit presents a curious appearance as it hangs on the tree with the fingers pointing upward.

After the bunches are cut from the stalks they are wrapped in leaves to protect them as much as possible, and are then conveyed to the nearest point of shipment. Sometimes mules are used in transporting the fruit, and in some cases canoes convey it to larger boats. The fruit is inspected at the vessel, and undesirable bunches are rejected. The bunches are packed on end in the hold of the vessel, the ordinary "fruiter" carrying from 15,000 to 20,000 bunches. The planter receives from ten to thirty-five cents per bunch for his fruit. As the bunches probably average eight dozen bananas each, the price to the producer seems low.

Central America, Jamaica, Cuba, Hawaii, the Samoan and the Fiji Islands produce bananas in abundance. The eastern part of the United States derives its supply chiefly from the West Indies, while the Pacific Coast is largely supplied from Costa Rica. The fruit goes by water to New Orleans, and thence by rail to Pacific Coast points. It is this long land haul that accounts for the high price of bananas in our Western States. Bluefields and Port Limon are

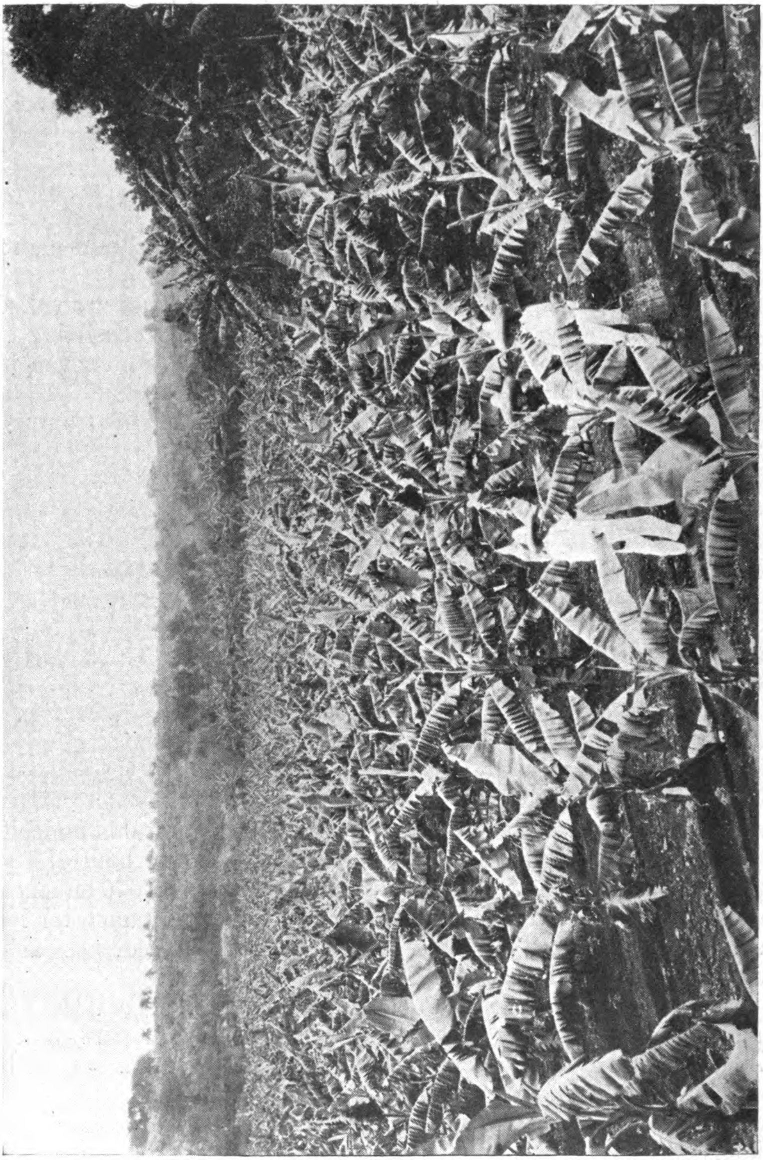

FIG. 99.—A banana plantation.

both important exporting points. Our average annual importation for the five-year period ending with 1918 was about 40,000,000 bunches. For this fruit we pay yearly more than $13,000,000.

In the tropics bananas are an important article of food, and they are cooked in a variety of ways. Ripe bananas contain about 22 per cent. of carbohydrates, and a given area when planted to this fruit will sustain five times as many persons as it would if planted to grain. This is a fact of great importance, for in the areas where the banana is a staple article of food climatic conditions are such as greatly to discourage human effort. From banana meal, cakes and bread are made. After being dipped in lye the fruit will keep almost indefinitely, and in this form is often carried long distances as a food. The tender shoots of the plant are sometimes used as a vegetable. A kind of wine is made by fermenting the juice, and the leaves enter into basket-making, and are used in thatching roofs.

Dates.—Among the many achievements of the United States Department of Agriculture during the last decade is the introduction and successful cultivation of the date palm tree. For several thousand years the date has been an important article of food along the historic Nile and Euphrates. In these modern days it enters largely into the commerce of the Sahara, Arabia, Persia and Turkey. One of the best date-producing regions is the Beled el Jerid (Land of the Palms). This area comprises several oases situated about 250 miles southwest of Tunis. There are about 30,000 people in this section, and they depend almost entirely upon the date industry.

The tree is a beautiful one, often rising to a height of 50 or 60 feet without a limb, and having a crown of feathery branches or leaves from 10 to 15 feet in length. During the youth of the tree, suckers or sprouts spring from its base, thus producing a thicket. Sprouts do not grow from old trees. The age of the date palm tree can not be told by the ordinary method, as it does not produce the rings within the wood, neither does the trunk continue to increase in diameter with increasing age.

The date palm may be propagated from seed or shoots, the latter being employed in order to save time. While the Arabs use no order in setting out trees, the French in their Saharan groves plant rows from 20 to 30 feet apart. While the trees are young the ground is used for some other crop, often grain. Only the female trees produce fruit, and in order to avoid cultivating a large number of non-productive trees, pollination is performed by man. A twig from a cluster of male flowers is placed within a sheath bearing a cluster of female flowers, and thus pollination is accomplished.

Within from four to eight years after planting, the trees begin to bear, and under favorable conditions continue to yield for a century. From 100 to 200 pounds of fruit is the average crop for a tree, although a single tree has been known to yield 600 pounds.

FIG. 100.—Date tree.

The fruit grows in bunches weighing from 10 to 40 pounds each. In gathering the most valuable varieties of dates from tall trees six or eight men may be required, as the bunches are handed from man to man stationed along the tree trunk. The less valuable fruit is dropped from the tree. The Deglet Noor is one of the finest varieties. It is imported extensively by Europeans and Americans.

Although the date palm flourishes in arid regions, it requires a continuous supply of water at its roots. An old Arab proverb says, "The date palm, the queen of trees, must have her feet in running water and her head in the burning sky." The tree is irrigated much more frequently than are orange or lemon trees. In the

Algerian Sahara the French count on twenty-four irrigations per year, seventeen of these occurring from June to September inclusive. In regions where the humidity is higher, or where water is close to the surface, not so much water is needed for irrigation.

The question of fertilizing the soil is a very important one in the desert regions where little live stock is kept. Commercialfertilizers are of course expensive. Leguminous plants, such as the alfalfa, are, because they can fix the free nitrogen of the air and store it up within themselves, of great value in date-palm culture.

For its successful cultivation the date palm must have a hot climate, and for the profitable preparation of the fruit there must be high temperature and a dry atmosphere. Although the tree will endure a lower temperature than the orange tree, a winter that would not injure a peach tree would kill a date palm. The tree will grow and flourish in regions in which it will not bear fruit. In southwestern California the date palm is a very common ornamental tree, yet it does not mature its fruit on account of the cooling effect of the steady sea breeze. Owing to this same breeze from the ocean, the air is too humid for the ripening of the date. Rains injure and sometimes destroy a crop. The mean temperature should be more than 70° F. during the entire fruiting season, and for one month more than 80° F. An examination of seasonal isothermal charts will show that there are few areas where these and the other necessary conditions obtain, and therefore the distribution of the date palm is very limited. A winter temperature above 20° F. seldom injures a date palm tree, and under certain conditions a somewhat lower temperature may be endured. Young trees, and trees not dormant, are injured most easily by the cold.

A peculiarity of the date palm enables the grower to thin the fruit in the most economical manner. Three fruits develop from each flower. If the flowers are pollinated, but one of these clings to the tree. If the flowers were not pollinated, none of the fruits fall. Such fruits are worthless, and are therefore cut off, relieving the tree of a useless burden.

When fully ripe, dates are reddish-brown or black in color, and sometimes contain as much as 60 per cent. of sugar. Sometimes the whole bunch is cut off at once, or again only the fully ripe dates are picked, leaving the others to ripen and be picked at a later time. The fruit is exported in boxes or leather bags.

It is possible to grow dates successfully in a few parts of the United States. In California there is one section, namely, the southeastern part of the state. The Colorado desert is well adapted to date culture. The summer temperatures are high, the air is dry, and the winters are mild.

In the Salt River valley, Arizona, dates are successfully grown. Much work has been done by the Department of Agriculture and the University of Arizona. In 1899-1900 about 400 young trees were imported from the Algerian Sahara and set out near Tempe. At the present time it seems likely that the United States can, in the near future, supply the home markets with domestic dates of the best quality, and as we import more than $500,000 worth annually this will be quite an important item.

STUDIES

What kinds of fruits are extensively produced in your state? Does the growing of fruit in your state lead to other industries? With what parts of Europe do Florida and California compete in marketing citrus fruits? Why is the cost of shipping citrus fruits from California to the central and eastern parts of our country so high? Do we have a duty on citrus fruits? Can bananas be grown in the United States? Compare bananas and wheat as to their percentage of carbohydrates. Why are so many apples grown in the western part of New York State?

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CHAPTER XXII

Miscellaneous Crops

CANE SUGAR

General Statement.--Cane sugar is the product of a plant belonging to the grass family. It flourishes in warm, moist regions, but for

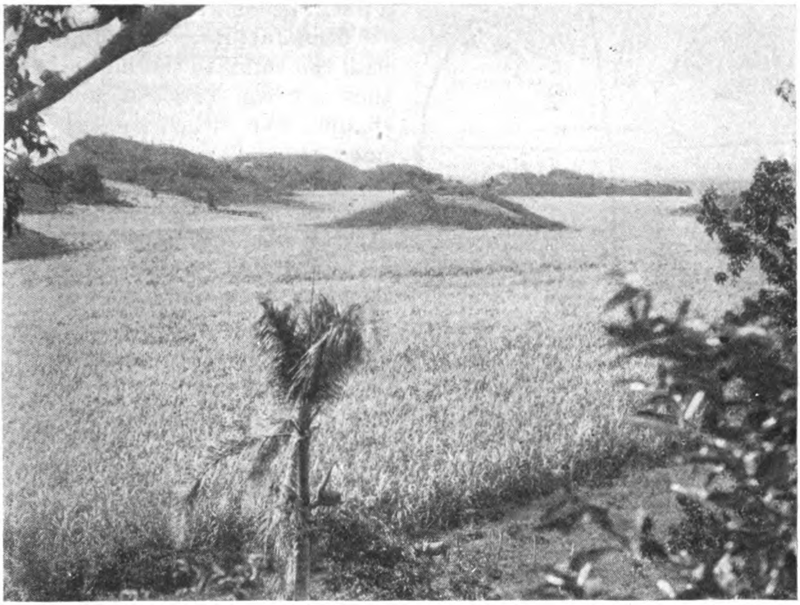

Fig. 101.—Sugar plantation near Carolina, Porto Rico. (U. S. D. A.)

its profitable production requires a soil rich in phosphates. The cultivation and production of cane sugar require a greater amount of labor than any other crop but tobacco. Cheap labor is therefore another essential for its production. Sugar is our most valuable import, amounting to more than $100,000,000 annually. We are the largest users of sugar in the world, consuming about 80 pounds per capita yearly.

Distribution.—The chief cane sugar-producing countries are India, Cuba, Java and the United States. Nearly all of the cane sugar produced in our country comes from Louisiana.

After the ground has been prepared, cuttings of the cane are dropped in furrows. From these grow the canes, which mature in about ten months. Sugar cane resembles corn, having joints with a spongy substance between, in which the juice is held. The canes vary from six feet to twenty feet in height, and from one to one and one-half inches in diameter. The canes are cut by hand, in sections about five feet long, and then loaded on tramcars which are run into the fields. A machine by means of which sugar cane can be cut is a much-needed improvement.

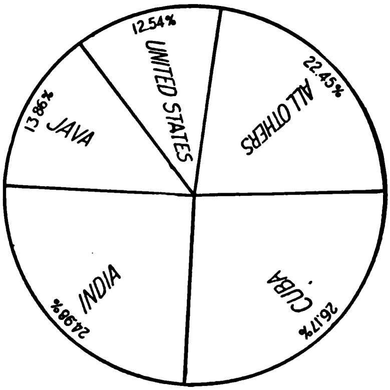

FIG. 102.—World's production of cane sugar. Percentages by countries. 1913-1917 inclusive.

Manufacture.—The tramcars haul the canes to the mill, where they are run between powerful steam rollers which squeeze the juice from the spongy matter. The stalks yield from 75 to 90 per cent. of juice and about 10 per cent. of the juice is sugar. After being put through the rollers, the stalks are sometimes used as fuel in the mill. The juice is now clarified and then sterilized at a temperature of 130° F. This sterilizing prevents fermentation, which would interfere with the crystallization. The sugar is now boiled until it reaches the point of crystallizing, when it is placed in centrifugal separators. Brown sugar and molasses are the products of this operation. The crude sugar then goes to the refineries, which are generally situated outside of the sugar-producing areas. This is because the cost of shipping crude and refined sugar is practically the same, and because the producing areas are not industrial regions. Brooklyn, Jersey City, Philadelphia, Boston, Baltimore, New Orleans and San Francisco are the chief refining centers in our country. The sugar is taken to the top story in the refinery, where it is dissolved in hot water and filtered. The liquid is then evaporated in vacuum pans, and the sugar allowed to crystallize. According to the process employed, we have loaf, granulated or powdered sugar.

BEET SUGAR

General Statement.—The sugar beet was grown in southern Asia before the beginning of the Christian era. It very slowly found its way to Europe, and it was not until 1747 that its value was discovered. Credit for making this discovery belongs to Andreas Marggraf, of Berlin. In 1801 the first beet-sugar factory was established in Germany, but not until 1840 was much progress made in beet-sugar production.

Distribution.—As the sugar beet requires less water and a lower temperature than does sugar cane, it has a much wider range. The chief beet-sugar-producing countries are: Germany, Russia, Austria-Hungary, France and the United States. In our country Colorado, Michigan, California, Utah, Idaho, Wisconsin and Nebraska are the states most important in the growing of sugar beets.

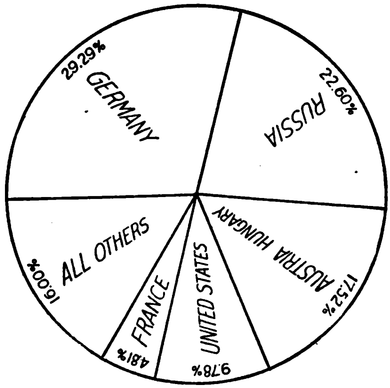

FIG. 103.—World's production of beet sugar. Percentages by countries. 1913-1917 inclusive.

Cultivation and Manufacture.—The seed of the beets is planted in rows, and the crop, which matures in from four to six months, is cultivated as are ordinary vegetables. The beets are dug by machinery, and the leaves are then cut off by hand, for these contain too much mineral matter to be of value in making sugar. From the fields the beets are carried to the factory by wagon or train, according to distance. At the factory each load is weighed and then dumped automatically into a stream of water, which carries the beets within the building. The beets are tested to ascertain the percentage of sugar carried, for upon this the price depends. About 16 per cent. of the beet by weight is sugar. The beets are sliced and soaked in warm water in order to remove the juice. The juice is then evaporated and the sugar refined by the same methods as those applied to cane sugar. The pulp is used as a food for stock.

Production.—In the production of beet sugar Germany ranks first, her output amounting to about one-third of the world's supply. In 1899 the United States produced about 81,000 short tons of beet sugar, while in 1918 about 750,000 tons were produced. In 1918 we had about 90 factories in operation. We now produce about one-fifth enough beet sugar to supply our entire demand for sugar of all kinds. In the semi-arid west, land adapted to the growing of sugar beets has rapidly advanced in price. The value of our output of beet sugar has increased more than 800 per cent. since 1899, and amounted in 1916 to about $75,000,000.

Much more expensive machinery is required for the cultivation and the manufacture of beet sugar than for cane sugar. On the other hand, there is less cost for transportation, as a considerable part of the beet sugar is consumed in sections where it is made. Germany has encouraged the cultivation of beet sugar by placing a bounty upon it and a tariff on cane sugar. The average yield of sugar beets per acre varies from about nine to thirteen tons. It is lowest in Michigan, and highest in Utah and Idaho. It has been found that the percentage of sugar can be increased by applying proper fertilizers to the soil. The grower of sugar beets frequently works under the direction of the manager of the nearest beet sugar factory. The farmer is told when to plant and when to harvest his crop, and if he does his work according to directions he has a certain market at a specified price.

Uses.—In addition to its extensive use upon the table, beet sugar is employed in the manufacture of candy, chocolate, jelly, jam, and in the preserving and canning of fruits. Although beet and cane sugar are essentially the same, some maintain that the latter has the greater sweetening power.

MAPLE SUGAR

General Statement.—In the early history of this country, the chief source of the sugar supply was the maple tree. The white man found that the Indian understood how to tap the trees and convert the sap into sugar, and for a long time the crude methods employed by the Indians were improved but little.

The making of sugar was for a long time a household industry, but in time it came to have a commercial importance. Maple sugar did not begin to be shipped to market until about the middle of the nineteenth century. Owing to impurities, the product was in these early days very dark.

Manufacture.—At the present time the trees are tapped by boring an auger hole three-eighths of an inch in diameter and one inch in depth. A wood or a metal spout is inserted in the hole, and the sap caught in wooden or galvanized iron pails. The sap is gathered in a metal tank having a cover, thus insuring cleanliness. In some groves the sap is piped to the camp, and in one case at least it is carried on a narrow-gauge track.

The evaporating is now done in great pans made for the purpose.

They are about six inches deep, forty inches wide, and from ten to eighteen feet in length. The pans are divided by partitions into a number of compartments. The sap enters at one end, and flows from side to side through the various compartments, being drawn off at the other end in the form of syrup.

Production.—While the demand for maple sugar has steadily increased, the output has not increased, and has since 1890 shown a great decrease. This decrease is in part due to a steady decrease

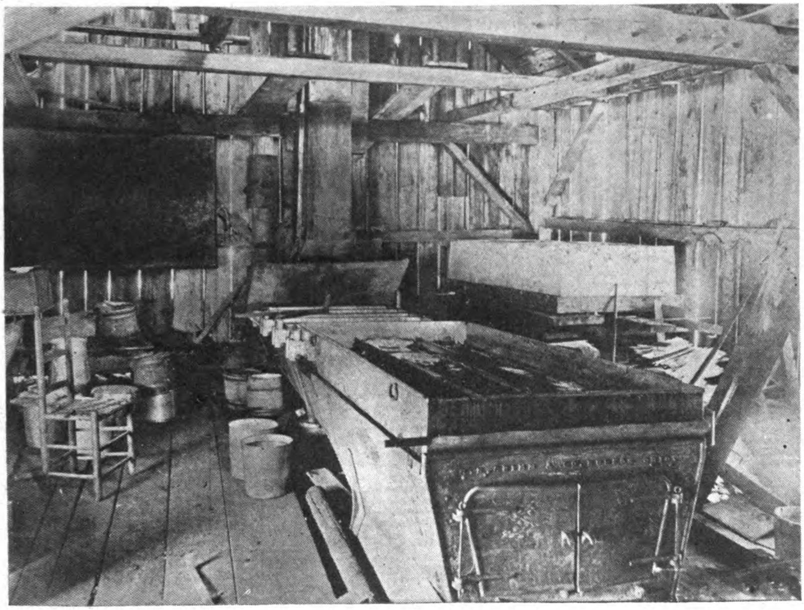

FIG. 104.—Making maple sugar.

in the number of maple trees owing to extensive cutting for lumber. It is also in part due to the fact that maple sugar is so extensively adulterated, that the genuine article does not command a price that encourages the producer. "At the very lowest estimate, seven-eighths of the product sold today is a spurious article, which is only in part maple sugar, or is manufactured entirely from foreign materials."[1]

It is interesting to note that while maple sugar was for a long time produced as food, it is now sold exclusively as a luxury. The demand at the present day is due entirely to the peculiar flavor of the sugar.

[1] "The Maple Sugar Industry," Forestry Bulletin No. 50, p. 9.

In 1918 the total value of the maple sugar and syrup produced in the United States was more than $10,000,000. The states of most importance in the maple sugar industry are Vermont, New York, Pennsylvania, Ohio, New Hampshire and Michigan. The portion of Canada adjacent to the Great Lakes is a maple sugar-producing region.

A thrifty tree of mature age will produce on the average about twelve gallons of sap, or three pounds of sugar, per season. Sap contains about three per cent. sugar. There are several varieties of

FIG. 105.—Potato field near Greeley, Colorado. (U. S. D. A.)

maple trees from which sugar is obtained, but the sugar maple, or *Acer saccharum*, is the most important.

The sugar season lasts from about the middle of March to the third week in April. The longest run on record is 43 days, and the shortest 8 days. As the season usually occurs when the farmer has little else to do, the work is more profitable than it otherwise would be. A large part of the total output is produced by the farmers.

POTATOES

General Statement.—The potato is believed to be a native of Chile, South America. It was carried to Europe by the Spaniards about 1580. Because of its very extensive use in Ireland, it was in comparatively recent years given the name of Irish potato.

The potato requires a very rich soil, and should not be grown for more than two years in succession on the same area. Failure to observe this is often the cause of a poor crop. As the roots of the plant penetrate the soil to a considerable depth, the ground should be loose and well drained. A sandy loam is very satisfactory. As a result of cultivation, the potato has practically lost the power to produce seed, and therefore the farmer plants the potato itself, which is an enlarged underground stem. The "eyes" are buds and each piece of a potato planted must have one or more eyes.

Distribution and Production.—Although potatoes are widely distributed, a few countries produce the bulk of the world's supply. Germany ranks first, with European Russia a close second.

TABLE 12.

AVERAGE ANNUAL YIELD FOR THE FIVE-YEAR PERIOD ENDING WITH 1914.[2]

Country	Bushels (round numbers)
Germany	1,700,000,000
European Russia	1,250,000,000
Austria-Hungary	660,000,000
France	500,000,000
United States	360,000,000
United Kingdom	260,000,000
World	5,500,000,000

TABLE 13.

AVERAGE YIELD PER ACRE, 1905-1914 INCLUSIVE.[3]

Country	Bushels	
United States	96	
European Russia	108	(1905-1913)
Hungary	120	
France	129	
Austria	156	(1905-1913)
Germany	204	
United Kingdom	213	

Although potatoes are grown on less than one per cent. of the cultivated land of the United States, the average crop for the five-year period ending with 1918 amounted to 380,000,000 bushels, valued at about $360,000,000. This immense amount does not supply our demand. For the decade ending with 1915, the value of the crop in our country increased 40 per cent.

[2]Compiled from figures in Yearbooks, U. S. Dept. of Agriculture.
[3]Yearbook, U. S. Dept. of Agriculture, 1916, p. 455.

The potato yields a larger return per acre than do the cereals. Germany and France take advantage of this, and export potatoes and import wheat. During recent years Germany has established many starch factories for the utilization of her potato crop, and she manufactures potato flakes and potato flour.

Through Southampton and Plymouth, Great Britain imports potatoes from France. She also receives potatoes from New Zealand. As the potato is an excellent keeper, it makes possible long-distance shipments by rail and water. The crop can be stored awaiting favor-

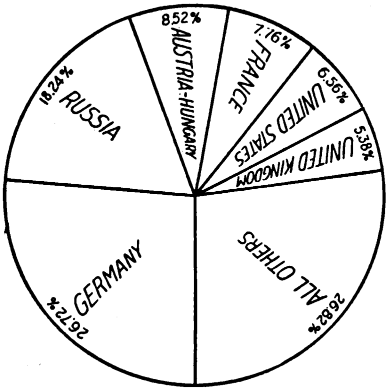

FIG. 106

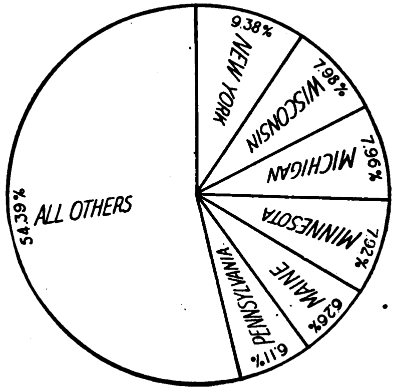

FIG. 107

FIG. 106.—World production of potatoes. Percentage by countries. 1915-1917 inclusive.
FIG. 107.—Production of potatoes in United States. Percentages by states. 1914-1918 inclusive.

able prices. The digging of the crop by machinery lessens the cost of production.

Food Value.—The potato consists of about 80 per cent. water, 2 per cent. protein, and 18 per cent. carbohydrates, chiefly starch. It is thus an unbalanced diet. Much more nutriment is obtained by boiling the potato with the skin on than by peeling it before boiling. Allowing the potato to stand in water after peeling decreases its value, because some of the mineral salts are dissolved, and there is also loss of starch.

HAY

In all countries where horses, mules, cattle or sheep are raised in large numbers, hay is a very important crop unless the climate is such as to permit the animals to forage successfully at all times of the year. Hay is dried grass, wild or cultivated, or less commonly it is wheat, barley, or oats cut before the grain has ripened, and fed as hay. Owing to the fact that grass grows in nearly all parts of the world, and to the great bulk of hay, even when baled, the trade in hay is chiefly domestic.

In the very mountainous parts of Germany, Switzerland and Austria grass is usually cut by hand, for machinery could not be employed. In the United States the scythe has given place to the mowing machine, and machines are in common use upon the European lowlands. Where the ground is level, a mowing machine will cut from eight to ten acres per day.

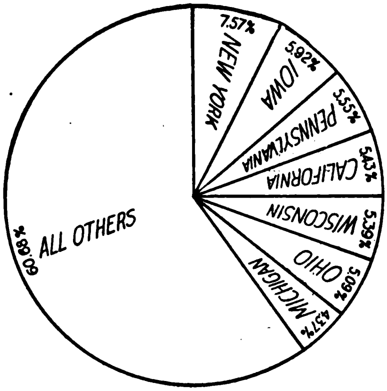

FIG. 108.—Production of hay in United States. Percentage by states. 1914-1918 inclusive.

For the five-year period ending with 1918 the average annual hay crop in the United States amounted to about 81,000,000 tons, valued on the farm at about $1,000,000,000. In our country hay generally ranks second in value among the crops. It is less expensive to produce than are most crops.

TABLE 14.

AVERAGE ANNUAL YIELD OF HAY FOR THE FIVE-YEAR PERIOD ENDING WITH 1915.[4]

State	Tons (figures in round numbers)
New York	5,700,000
Iowa	4,450,000
Pennsylvania	4,200,000
Wisconsin	4,000,000
Ohio	3,501,000
California	3,500,000
Michigan	3,000,000
United States	69,000,000

All of the states named are important dairy states, and in most of them there are large cities where thousands of horses and mules are used.

[4] From Yearbooks, U. S. Department of Agriculture.

TOBACCO

The cultivation of tobacco was quite closely connected with the early history of our country. The plant is native of America, and at

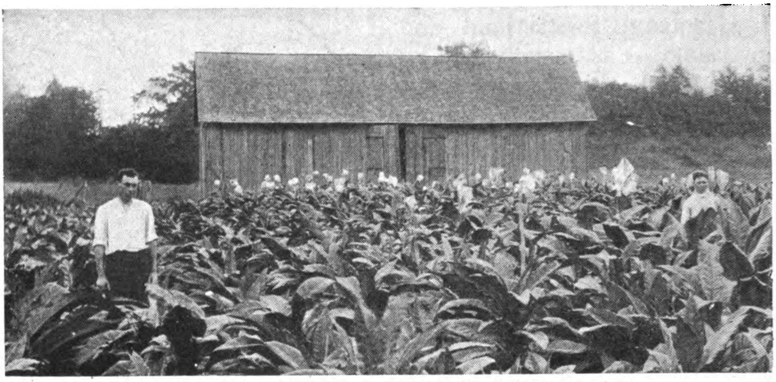

FIG. 109.—A Maryland tobacco field. (U. S. D. A.)

the time of the discovery of our continent it was in general use among the Indians. It was early introduced into Europe, and its use rapidly spread to all parts of the world.

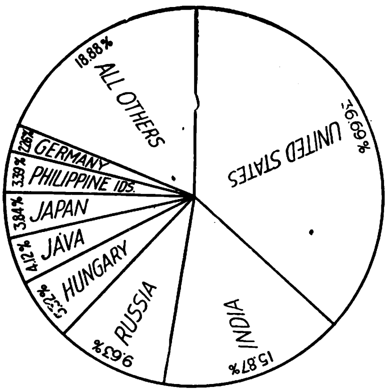

FIG. 110

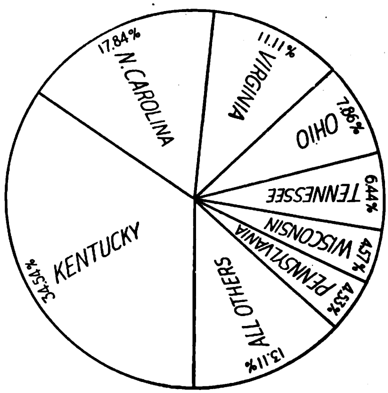

FIG. 111

FIG. 110.—World's production of tobacco. Percentages by countries. 1913-1917 inclusive.
FIG. 111.—Production of tobacco in the United States. Percentages by states. 1914-1918 inclusive.

In the tobacco fields of Virginia slaves found their first employment in this country. As the crop rapidly exhausts the fertility of the soil, plantations were used for a very few years and then abandoned for new areas. This was possible because land had so little value.

The large plantations meant sparse population and poor roads. Tobacco was the one great crop in Virginia. As early as 1689 this colony was exporting 8,000 tons per year to the mother country. On account of the scarcity of money, tobacco was accepted in payment of salaries, taxes and debts of all kinds.

The "Navigation Act," passed by the English Parliament in 1660, was a serious blow to the tobacco planters. It provided that various commodities, among them tobacco, could be exported to England only, and in ships owned and navigated by Englishmen.

TABLE 15.

AVERAGE ANNUAL YIELD OF TOBACCO FOR THE FIVE-YEAR PERIOD ENDING WITH 1914.[5]

Country	Pounds (round numbers)	Rank
United States	987,000,000	1
British India	450,000,000	2
European Russia	218,444,000	3
Hungary	154,815,000	4
Java	107,598,000	5
Japan	93,129,000	6
World	2,668,623,000	

Other countries of considerable importance in the production of tobacco are: Germany, European Turkey, the Philippine Islands and Cuba. As is shown by Table 16, Kentucky is the leading producer in our country, and Louisville is the greatest tobacco market in the United States. Fine Sumatra tobacco is now grown in the Connecticut valley, where fields sometimes several acres in extent are protected by awnings and walls of cloth. The annual tobacco crop in the United States is worth about $100,000,000.

TABLE 16.

AVERAGE ANNUAL YIELD OF TOBACCO FOR THE FIVE-YEAR PERIOD ENDING WITH 1914.[5]

State	Pounds (round numbers)	Rank
Kentucky	340,000,000	1
North Carolina	150,000,000	2
Virginia	130,000,000	3
Ohio	75,000,000	4
Tennessee	65,000,000	5
Pennsylvania	52,000,000	6
Wisconsin	45,000,000	7
United States	900,000,000	

[5]Yearbooks, U. S. Department of Agriculture.

HOPS

Although we produce large quantities of hops, we import some from European countries. The largest growers of hops are the United States, Austria-Hungary, Germany and England. For many years hop-growing was practically confined to Central New York State. Washington, Oregon and California are now important.

FIG. 112.—Picking hops.

The hop plant is usually propagated from cuttings. As the roots penetrate the ground to a depth of several feet, a well-drained subsoil is essential. The plants are set out six to eight feet apart each way. Wires fastened to the tops of posts are stretched over the fields, and strings conduct the plants to the wires

As the hops when harvested contain a very high percentage of moisture, they must be dried before they can be with safety stored. Artificial heat is sometimes employed for this purpose.

The chief use of hops is in the manufacture of malt drinks. The most important hop-producing countries were formerly the leading countries in the manufacture of beer.

COCOANUTS

The cocoanut palm grows in tropical regions only, and usually quite close to the coast. The tree is very graceful, terminating in a

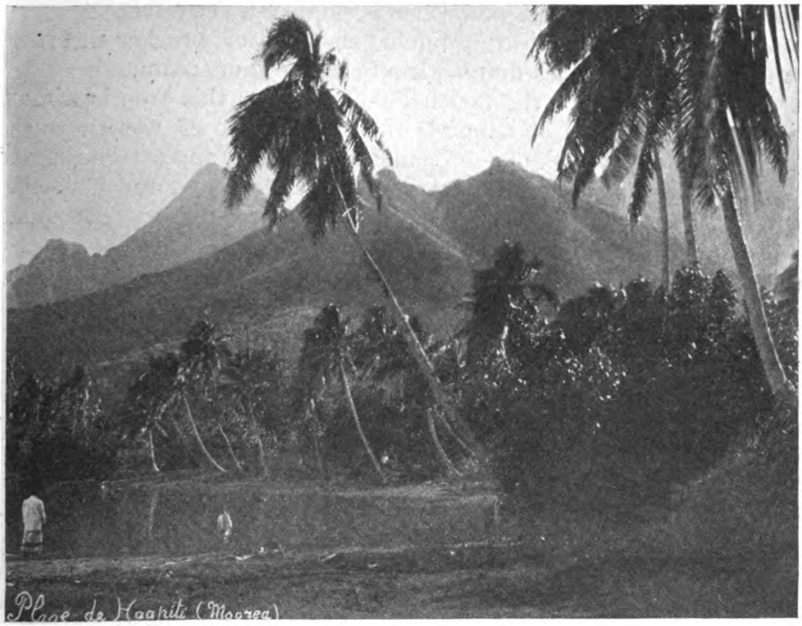

FIG. 113.—Cocoanut trees, Tahiti. Courtesy L. F. Cockroft.

crown of drooping, feathery leaves, each one of which is from ten to fifteen feet in length. In some cases this crown is 80 or even 100 feet above the ground.

A cocoanut plantation is started by planting the nuts in a nursery and later transplanting the young trees. A full crop, which is not secured for perhaps fifteen years after planting the trees, consists of 100 to 200 nuts per tree. The nuts grow in clusters, and are harvested by climbing the trees and cutting the nuts from the stems.

When unripe the nuts contain a jelly-like substance, in which there is a liquid sometimes called cocoanut milk. As the nut ripens this material hardens. When dried the kernel is known as *copra*.

From the ripe kernel cocoanut oil is obtained. This is used for cooking, for illumination, in the manufacture of soap and candles, and by the natives of the islands where the tree grows for anointing the body.

The trunks of the trees are used in the construction of houses, the leaves for thatching and for the manufacture of baskets and fans, the shells for utensils of many kinds, the bark for tanning, the roots for medicine, and the terminal bud is eaten as a vegetable. A coarse brown sugar, an intoxicating liquor, and matting, brushes and ropes are other commodities derived from the cocoanut palm.

To the people of the South Pacific Islands this tree is almost indispensable. The cocoanut is the chief source of wealth to the inhabitants of the Samoan Islands. The Hawaiian Islands, the Philippine Islands, the West Indies, Central America, and Colombia are other areas where the cocoanut tree flourishes. Some cocoanuts are produced in Florida.

PEANUTS

We are so accustomed to seeing peanuts sold in five-cent packages that it is difficult to realize the value of the crop. During the decade ending in 1909 the acreage devoted to this crop in the United States increased 68 per cent. and the yield increased 62 per cent. This remarkable increase is due to the fact that in a measure the peanut has come to take the place of cotton as a crop, to the manufacture of peanut oil, peanut butter and peanut confections, and to the introduction of machinery in digging and picking the crop.

In 1918 we produced more than 50,000,000 bushels, the value of which was more than $95,000,000. In addition to this enormous amount we imported a large quantity. Table 17 shows the yield in round numbers in the chief peanut-growing states in 1918.[6]

TABLE 17.

State	Bushels
Alabama	17,000,000
Georgia	10,000,000
North Carolina	7,000,000
Texas	7,000,000
Virginia	6,000,000
Florida	5,000,000
Tennessee	700,000

[6]Yearbook, U. S. Department of Agriculture, 1918, p. 562.

The peanut is grown extensively in western Africa, China, Japan, East Indies, Brazil, Spain and other semitropical regions. For its successful cultivation the plant requires a climate that is free from frost for a period of five months. The best soil is a sandy loam containing considerable lime.

In European countries much peanut oil is manufactured, and it

FIG. 114.—A peanut digger. (U. S. D. A.)

is used as is olive oil, which it is said to equal, although it is much cheaper. The price ranges from fifty cents to one dollar per gallon. The city of Marseilles manufactures this oil extensively.

As the peanut contains about 29 per cent. of protein, 14 per cent. of carbohydrates, and 49 per cent. of fat, its value as a food is evident. From broken and low-grade nuts, peanut meal, a valuable cattle food, is made. The vines are fed to cattle. They make an excellent fertilizer because they contain nitrogen, phosphoric acid and potash. If the entire crop is removed from the soil it rapidly exhausts its fertility.

The peanut is not a nut, but it is popularly so regarded. In reality it is a ground pea. It is an annual, and produces its fruit underground. Because it has the ability to take nitrogen from the atmosphere, it is sometimes grown for the purpose of enriching the soil.

STUDIES

Is the demand for hay increasing or diminishing? What special advantage in the potato as a farm crop? Is the importation of sugar by the United States likely to increase? From a study of the temperature and rainfall charts of the United States, determine the temperature and moisture conditions required by sugar cane. Compare the value of our annual tobacco crop with that of our annual output of gold. Why are nuts valuable as a food? Are nuts as ordinarily used in this country economical as a food? Are nuts produced extensively in your state?

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PART THREE

THE FORESTS AND MAN

CHAPTER XXIII

FORESTS AND FORESTRY

General Statement.—"If there is any one duty which more than another we owe to our children and our children's children to perform at once, it is to save the forests of this country, for they constitute the first and most important element in the conservation of the natural resources of the country."[1]

From the dim past, when our ancestors were tree-dwellers, to the present day, forests have been intimately related to the welfare of man. The houses in which we live, the furniture which they contain, the vehicles and ships in which we travel, are made in part from forest trees. From the forests are derived certain foods, as well as materials which enter into the manufacture of clothing. The papers, magazines and books that we read have, in many cases, been made from spruce or hemlock trees. From the forests is obtained much fuel, the material used in making cross-ties, telegraph and telephone poles, fence-posts, mine supports, boxes, barrels, farming tools and machinery, matches, pencils, spools and countless other things in daily use. Forests are of inestimable value in regulating stream-flow, thus conserving the water supply and lessening floods. This has an application to irrigation, navigation, the development of power, the removal of soil, as well as loss of property and life. Trees add a charm to the home and the street; they beautify the landscape, and they weave their influence into the spiritual as well as the material life of man. Each summer thousands of persons seek the forests in search of recreation, health or pleasure.

There are thus many reasons why we should study the forests. We should know their distribution, and upon what this depends. We should understand how to make them of the most use in supplying materials for various purposes. We should learn how they may serve to check the removal of soil from the slopes, and the destruction of property and life wrought by floods. We should study the prevention and control of forest fires which cause great losses annually. We should not only conserve and scientifically handle existing forests;

[1]Roosevelt, Theodore: "Message to Congress, Dec. 8, 1908."

we should extend the timber-land by planting trees on available tracts.

Distribution.—Temperature and precipitation are the keys to the natural distribution of forests. Generally speaking, natural tree growth is not abundant in regions where the average summer temperature is less than 50° F., and the average annual precipitation is less than 20 inches. The seepage of water sometimes accounts for the extension of forest areas into sections where the yearly precipitation falls short of this, however.

In the tropical forests of Central America, South America, Africa and southern Asia are found the various palms, the banana, the banyan, the rubber, the mahogany, rosewood and many other kinds of trees. In the gloomy depths of these forests the white man finds no congenial home, although he draws from them much wealth.

On the poleward sides of the tropics are the temperate latitude forests. These may be divided into coniferous and deciduous. The cone-bearing trees occupy high altitudes and latitudes, while the deciduous trees are found at lower levels and latitudes. The economic importance of the temperate latitude forests is far greater than is that of the forests of the tropical zone.

In the Old World, Russia contains the greatest forest area. Thirty-six per cent. of European Russia is classed as timber-land, an area equal to four times the area of France. In addition, there are vast forests in Siberia. Austria-Hungary, Norway, Sweden, Germany, Rumania and France have extensive forest areas.

In the United States there are five important forest areas: the New England, the Lake region, the Southern section, the Rocky Mountain section, and the Pacific Coast States. Washington, Oregon, Idaho and California contain about five-elevenths of the standing timber in our country. Our total forest area is about 550,000,000 acres, or 18 per cent. of our land area.

Forests and Floods.—A forest cover is of the greatest importance in regulating stream-flow. The underbrush, vines, creepers, ferns, grass and vegetable mould combine to form a veritable sponge which prevents rapid run-off. Under these conditions the water slowly seeps through the soil and works its way to the streams. The rills and small streams, being fed slowly and constantly, are not subject to flood, and are permanent rather than intermittent in their flow.

A study of the relations between forests and run-off was made in the San Bernardino Mountains of southern California.[2] Three

[2]James W. Toumey, Collaborator, Bureau of Forestry: "The Relation of Forests to Stream-Flow." Yearbook of Dept. of Agriculture, 1903, pp. 286-287.

basins having similar topography and varying in area from one-half to one and one-half square miles were chosen. The smallest of the three basins was non-forested, but the others were forested. The rainfall in the non-forested basin was much less than that in the forested basins, and the run-off was much more rapid.

Since sunshine is to some extent excluded from a forest, and the wind cut off, the removal of snow both through melting and evaporation is checked. In non-forested regions the rapid removal of snow

FIG. 115.—Map of United States, showing timber and prairie areas. Unshaded area, Prairie. Dark shade in Northeast and North, Central forests. Lighter shaded area in Southeast, Southern forests. Very lightly shaded area, Rocky Mountains forests. Deep shade, Pacific Coast forests. (Graves, U. S. D. A. Forest Service.)

is often the cause of floods. When streams are in flood they carry great loads of rock waste. When the streams bearing their loads of boulders, gravel, sand and mud pass from steep to very gentle slopes, their velocity is checked, carrying-power diminished, and the material deposited. As a result, large areas are sometimes rendered unfit for agriculture.

Our country is so young, its resources so vast, and its population so sparse, that we are but beginning to realize the danger that threatens us as a result of the removal of our forests. In the upland districts of the South much damage has been done as a result of the removal of timber from the Appalachian Mountains.

Forests as regulators of stream-flow are of vital importance in

France, because she has so many torrents. Originating in the Pyrenees, Alps and Cevennes are 1,462 streams classed as dangerous. Nearly a million acres of mountain slope and much level land are exposed to the work of these streams. As early as the sixteenth century local restrictions preserved the mountain sides from deforestation, but these restrictions were entirely disregarded during the time of the French Revolution. "Where useful brooks had been there now rushed torrents which flooded the fertile fields and covered them with sterile soil washed down from the mountains. The clearing continued unchecked until some 800,000 acres of farm land had been ruined or seriously injured, and the population of eighteen departments had been reduced to poverty and forced to emigrate."[3]

In 1860 the state undertook the establishment of protection forests. A law passed in 1882 provides that the government shall bear all of the expense. So fully are the people in sympathy with the movement that much mountain land has been given to the Forest Department, and the state purchases considerable areas each year. More than 500,000 acres have been acquired, over one-half of which have been planted. Since 1882 one hundred and sixty-three torrents have been placed under complete and 654 under partial control.

In the mountainous districts of France, Switzerland, Austria and other European countries one sees the banks of even the small streams protected by a sort of woven mat of poles and twigs held in place by poles driven into the ground. In Spain and Italy streams have done much damage as a result of removing the forests. China has suffered irreparable loss. Soil has been removed, the water-table lowered, and property and life lost because of floods.

Because forests regulate stream-flow, they are of great value to agricultural lands, and to irrigated lands in particular. The clearing of timber from the slopes renders rivers less navigable, not only because of decreased flow, but also because of the choking of the streams with rock waste. The water-power available for manufacturing is very unequally distributed as to time, and industry is retarded.

Forests and Sand Dunes.—Forests check the removal of the soil by the winds as well as by water. In 1793 France commenced the planting of trees on the dunes along her western coast. These ridges of sand the winds were slowly driving landward, destroying valuable vineyards as they went. The migration of the dunes has been stopped, and the forests growing upon them yield crops of wood

[3] Treadwell, Cleveland, Jr.: "What Forestry Has Done." Forest Service Circular 140.

and resin. Farther inland, in the region known as the Landes, both sand and swamp lands have been reclaimed.

The city of Provincetown, on Cape Cod, which is extensively engaged in fishing and shipping, has, together with its harbor, suffered much because of shifting sands. Within historic times considerable areas now covered by dunes were forested. The timber was removed, to be used as fuel and in building houses and ships, and

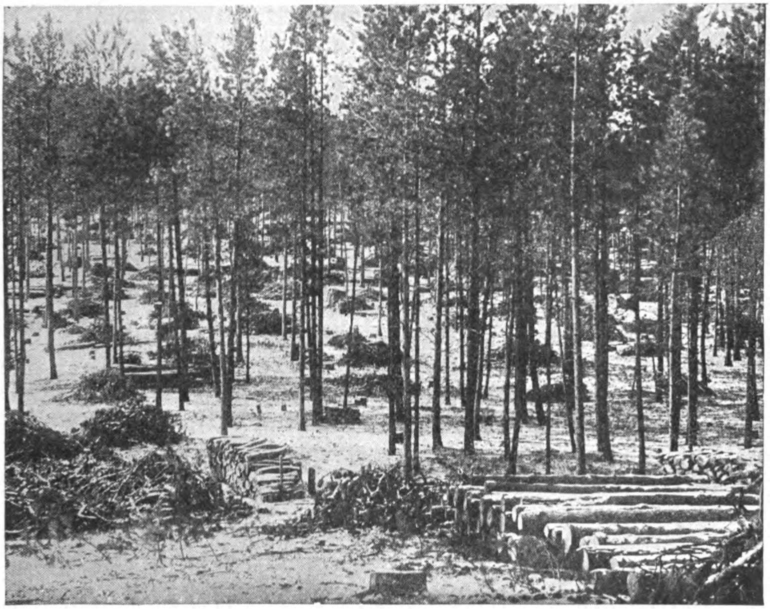

FIG. 116.—A well-managed wood lot.

much was destroyed because of the pitch and turpentine industry.

As a result of this deforestation, the dunes encroached upon the city so that "large amounts of sand were artificially removed to prevent the burial of houses." That part of the bay known as East Harbor was completely destroyed, and only a fresh-water marsh marks its former location. For 150 years beach grass has been planted to check the movement of the sands, and while this has done much, reforestation is now looked to as the only solution of the difficulty. The magnitude of the work is shown by the statement that "the General Government has spent to June 30, 1903, the sum of

$162,019.86 for the protection of the harbor." In addition, the state has spent large sums.

Forests and Rainfall.—There has long been a widespread belief that forests induce rainfall. To a considerable extent, at least, the *result* has been mistaken for the *cause*. Primarily, vegetation exists because of favorable climatic conditions, not climatic conditions because of vegetation.

Precipitation is caused by the cooling of the atmosphere, which increases its humidity to the point of saturation. This lowering of temperature comes about in three ways:

1. In the doldrums the air is constantly rising to great altitudes; hence in this belt rains are of daily occurrence.

2. When an air current comes in contact with a mountain range it is forced to rise, and rain is likely to occur on the windward side.

3. On the forward side of the great cyclonic areas which move across the temperate zones in a general easterly direction, conditions are favorable for precipitation, for here the air is moving from areas of higher to areas of lower temperatures. In view of these points we may ask whether forests have any effect upon rainfall.

Within a forest the summer temperature is slightly lower than it is in the adjacent non-forested areas. The trees retard the movements of the atmosphere. The process of evaporation is therefore checked. Through transpiration every large tree is returning annually many tons of moisture to the air, which, because of the low rate of evaporation, increases the relative humidity. It would therefore appear that the forests have a *tendency* to increase precipitation, for the air within a forest might reach the saturation point, while the air in adjacent non-forested areas would be above this point. Any increase in precipitation resulting from forests would no doubt be very local in character.

In order to decide on the extent to which forests influence rainfall, accurate records covering large areas and many years are necessary. These records should apply:

1. To areas formerly forested, but now devoid of timber.
2. To areas formerly treeless, but now having a forest cover.
3. To areas where all but forest conditions are as nearly identical as possible.

Such studies of this problem as have been made in both the Old and New Worlds vary in results. In Bavaria, India and the United States the excess of rainfall in the forested areas is very slight. In some cases there is apparently no excess.

Studies in France and Russia show that in some cases the rainfall in forested areas is no greater than in that of adjoining areas not forested, while in other cases the excess amounts to 43 per cent. Many of the leading meteorologists in our country and in Europe believe that forests have little influence upon rainfall. It might be repeated at this point that the forest cover *conserves* the water supply, and is thus of inestimable value.

Reforestation.—In the early periods of the history of this country our forests seemed inexhaustible. They were, in fact, an obstacle to development. The pioneer was obliged to cut and burn the timber and grub out the stumps before he could cultivate his land and raise crops. For a long time the forests of New England met all local demands, and furnished much timber for exportation. The marvelous development of this country, and the constant European demand, drew in time upon the white pine resource of the Lake region. Later the yellow pine belt of the South was invaded. Today the forests of the Pacific Slope are being rapidly felled. We are now cutting annually about three times as much timber as grows during the same period, hence the outcome is perfectly evident. In addition, the loss of our forests means a failing water supply and agricultural lands turned into desert wastes.

It is obvious that it is a difficult matter to induce individuals to handle their forest possessions in such a way as to make for the interests of future generations. The necessity of placing forest areas under government control is therefore apparent. On March 3, 1891, Congress authorized the President to "set apart and reserve, in any state or territory having public lands bearing forests, any part of the public lands wholly or in part covered with timber, or undergrowth, whether of commercial value or not, as public reservations." In the same year President Harrison created the first—the Yellowstone National Forest. On Washington's Birthday, 1897, President Cleveland set aside thirteen areas as national forests—a most fitting celebration of a great day. There were in the United States on June 30, 1917, 152 national forests, with a total area of about 155,000,000 acres.

Within the national forests there are small tracts of agricultural land. These are open to settlement in the ordinary way. Mineral lands may also be filed upon and developed. Such timber as is required by the actual home maker is given him. It is also given to communities when required for public purposes. Others must purchase. Twenty-five per cent. of the amount derived from the sale of the timber is applied to county, school and road funds in the states in which the national forests are located, provided that this amount shall in no case exceed 40 per cent. of the total tax in such counties. The government allows the owners of stock to graze their animals in the forests, a low rental being required for this privilege. Our forest policy, as established by the Act of June 4, 1897, is as follows: "To improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of water flow, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States; but it is not the purpose or intent of these provisions, or of the act providing for such reservations, to authorize the inclusion therein of lands more valuable for the mineral therein, or for agricultural purposes, than for forest purposes."

The construction of roads, trails, telephone lines, bridges, cabins and fire-breaks, the planting of trees and seeds, the fighting of fire and the care of the forest generally, requires a large force of men trained in woodcraft. These men are selected from those who have passed a Civil Service examination. In 1919 there were some 5,000 persons in the employ of the Forest Service.

Cost and Returns.—For the year ending June 30, 1916, the appropriation amounted to about $5,500,000. During the year 1918 the sum of $1,619,369 was derived from the sale of timber from the national forests, and the revenue from all sources amounted to $3,574,930.

Through the prevention and fighting of fires the Forest Service saves large sums annually. These fires are in many cases the result of carelessness on the part of hunters, campers and others. In the summer of 1902 fires raging in Washington and Oregon for nine days destroyed timber valued at $12,000,000. During the calendar year 1910 fires in the national forests caused a loss of $25,000,000. It is not simply the mature timber that is lost, in such cases, but the young growth and the underbrush as well.

"It has been shown that one-eleventh of all the forests are swept by fires every year, and that on the average since 1870, forest fires have yearly cost $50,000,000 and 50 lives."[4] Owing to the extension of trails, roads, fire-breaks and telephone lines, as well as to greater care on the part of the public, forest fires do much less damage now than formerly. Each ranger patrols on the average 121,506 acres.

Reforestation is chiefly a matter of benefit to future generations. Irving said, "He who plants an oak looks forward to future ages and

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[4] "The Status of Forestry in the U. S." Forest Circular 167, p. 3.

plants for posterity. Nothing can be less selfish than this." The same may be said of the planting of trees upon our mountain slopes. The trees are raised from seeds at nurseries in the forest, and are transplanted by rangers. During 1916 seeds were sown on 2,803 acres, and trees were planted on 7,593 acres. In humid regions the sowing of seeds in the forest has produced satisfactory results.

Practically every civilized nation practices forestry. China, so long

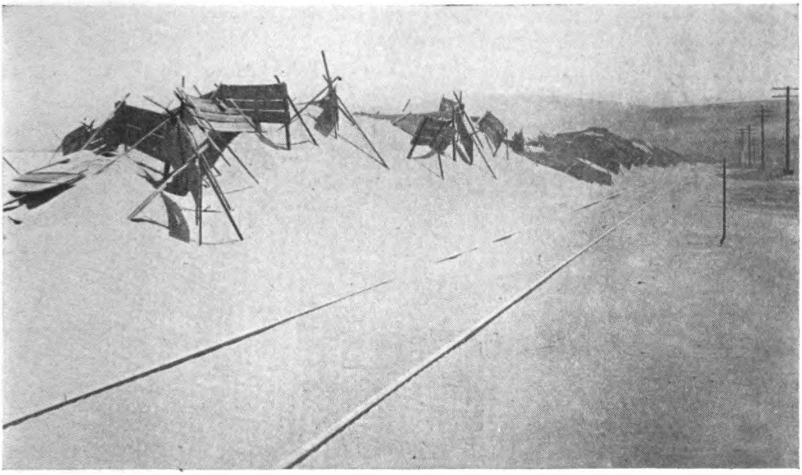

Photo by Chamberlain.

FIG. 117.—Sand dunes along the Columbia River.

inactive on this line, has made a beginning. European countries are far ahead of us, for with them forestry is well established, and its value is clearly seen. A century and a half ago Germany began to feel the effects of a timber shortage, and to realize the loss to agriculture from the removal of the forests. This led to the development of a Forest Service, which has been so scientifically handled that in 1904 the net returns from the forests of Prussia were $2.50 per acre, while the output of timber is steadily increasing. In the Black Forest the income from the trees is more than sufficient for the maintenance of the splendid system of roads.

The Republic of Switzerland expends from $1.50 to $7.00 per acre annually upon her forests, and receives a net profit of from $3.00 to $12.00 per acre yearly. The law requires that logged areas must be replanted within three years from the time of the cutting.

The area on the northeast shore of the Adriatic, and known as the

"Karst," furnished Venice with timber for centuries. The clearing of the land reduced this region to an almost worthless condition. Since 1865, 400,000 acres in this district have been planted to forest trees.

Russia, although still having vast forest areas, began the work of forestry long ago. The liberation of the serfs in 1861 temporarily checked the handling of the forests. The government now owns 79 per cent. of the forest area. Forests which prevent the migration

Courtesy W. G. Scott.

FIG. 118.—In a national forest.

of sands, regulate the stream-flow, or hinder avalanches are classed as "Protection Forests" and may not be cleared. In order to encourage tree-planting on private holdings the government distributes seedlings free of cost. The net income from the government forests averages about three and one-fifth cents per acre. In Finland the cutting of trees that measure less than ten inches in diameter at a height of 25 feet from the ground is prohibited, and not more than twelve acres may be cut without preparing for a new growth.

Italy and Spain have suffered severely as a result of the removal of forests. Streams which were formerly permanent are now dry during the summer months. In 1897 a flood near the city of Bologna did damage to the extent of $1,000,000. No nation has sustained a greater loss as a result of deforestation than has China. Northern

China has practically no timber. Erosion has worked rapidly upon the denuded slopes, soil has been washed away, and floods have wrought tremendous havoc. Extensive areas which once supported a dense population are now practically deserts.

Consul Ernest L. Harris, of Smyrna, Turkey, says of the results of deforestation in that land: "The disappearance of the forests in this country, especially in the vilayet of Smyrna, has been marked by greater degrees of heat and cold. The date palm has practically become extinct in these parts. In the winter and spring there are usually floods, which are destructive to life, property and crops. In the summer there is not sufficient moisture in the soil of many districts, for the reason that the rain passes away at once down woodless ravines, without being absorbed by the ground. As a result large tracts have become sterile. Creeks and brooks which formerly retained considerable water, even in the heat of summer, are now completely dried up a few weeks after the spring rains."[5]

Forestry is a subject in which our own and every enlightened nation is today deeply interested. The conservation of our forest resource, and the reforesting of denuded areas, are matters which concern the welfare of every resident of our land. The waste of national wealth means loss to every man, woman and child, just as truly as the loss of the possessions of a family means suffering to every member of that family.

In 300 years we have brought an inheritance which seemed absolutely inexhaustible to the point where poverty faces us. There are men now living who have seen valuable timber burned in order to clear the land. They have seen the best of walnut and maple used for fuel, and yet, according to our highest authorities, our supply will, at the present rate of consumption, last but a comparatively short time.

In wasting our forests we have suffered great loss in other ways. The streams, unrestrained because of the removal of the forest cover, have swept vast quantities of fertile soil from the land, thus lessening productivity. This is painfully apparent in many districts in the South. This soil, after choking rivers and harbors to the detriment of navigation, is dredged out at great cost. Floods have increased, and annually cause much loss in city as well as in country. The water-table has been lowered, thus adding to the cost of raising the water to the surface. Water-powers are threatened, and this is striking at one of our greatest resources.

[5]Consular Reports, May, 1908, p. 182.

If we would profit by the experience of China, Turkey, Greece, Italy, Spain and France, our Forest Service must receive abundant support, and individuals must coöperate by exercising the greatest care to prevent forest destruction by fire and other means.

Only by prompt, vigorous, intelligent action shall we be able to transfer even a small part of our vast inheritance to those who are to come after us, and who must suffer great loss if we continue unfaithful to our trust.

STUDIES

Are there any national forests in your state? Locate them. How may each individual help to conserve our timber supply? Is government ownership of the forests desirable? Why? Why is forestry in New Mexico more of a problem than it is in Maine? Why do European countries derive more profit per acre from their forests than do we?

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CHAPTER XXIV

Forest Products

LUMBER

General Statement.—When the white man landed upon the shores of America, and indeed as late as one hundred years ago, the forests of this country seemed inexhaustible. Before the settler could plow the ground he had to clear it of trees, and then dig out the stumps. This was a task requiring much hard labor. What was in the boyhood days of Abraham Lincoln a serious hindrance to the development of many sections of the United States has now become one of our most valuable, and at the same time rapidly disappearing, resources.

Our experience simply repeats that of many countries in the Old World. England, once forest-covered, has now little timber. Italy, Spain, France, Germany, Austria have suffered serious losses. China is almost destitute of trees. A country bountifully supplied with timber has an important source of national prosperity, while one deficient in this respect is dependent upon others for a commodity of great importance.

Distribution of Lumber.—A few nations supply the world with lumber. The most important of these are: Russia, including Finland, Norway, Sweden, Austria-Hungary, India, Canada and the United States. In European Russia there are about 444,000,000 acres of forest land, or 36 per cent. of the total area, and in Siberia 350,000,000 acres more. Russia exports some $30,000,000 worth of forest products per year, and tremendous quantities of lumber and fuel are used at home. About 48 per cent. of Sweden is forest-covered, and both she and Norway are heavy exporters of lumber. Austria and Hungary are exporters, but Germany, although having vast forests, is not able to supply her demand for lumber. Great Britain, France, Switzerland, Spain and Italy all import lumber.

Canada has vast forests and a small population. In British Columbia, where the temperature is moderate and the precipitation abundant, tree growth is magnificent. Here the red fir, red and yellow cedar, western spruce, hemlock and other trees abound. This timber belt stretches from the forty-ninth to the sixtieth parallel, and is two or three hundred miles in width. In northern Canada there is a still more extensive forest. This belt extends from the east coast of Labrador to Alaska. The dimensions of this forest, which is largely of spruce, are roughly 3,000 miles from east to west, and 500 miles from north to south. The southern Canadian belt is located in

FIG. 119.—Marking timber to be cut in a sale in a national forest in the Southwest. (U. S. D. A.)

Ontario and Quebec. As this forest is situated so close to the great manufacturing centers of the United States, it is of great value to us.

The extent of forest land in the United States is estimated at 550,000,000 acres, or 18 per cent. of our total area. There are five forest belts: the New England, the Lake States, the Southern States, the Rocky Mountain States, and the Pacific Coast States.

From our Atlantic seaboard, lumber is exported to European markets, while from Bellingham, Everett, Tacoma, Seattle, Portland and San Francisco lumber is sent to South America, Australia and the Orient.

Operation.—Felling the forest trees, transporting them to saw-mills, and cutting them into boards and other commercial forms, is known as lumbering. This industry is in itself of great importance, and it gives rise to many others of much economic value. These

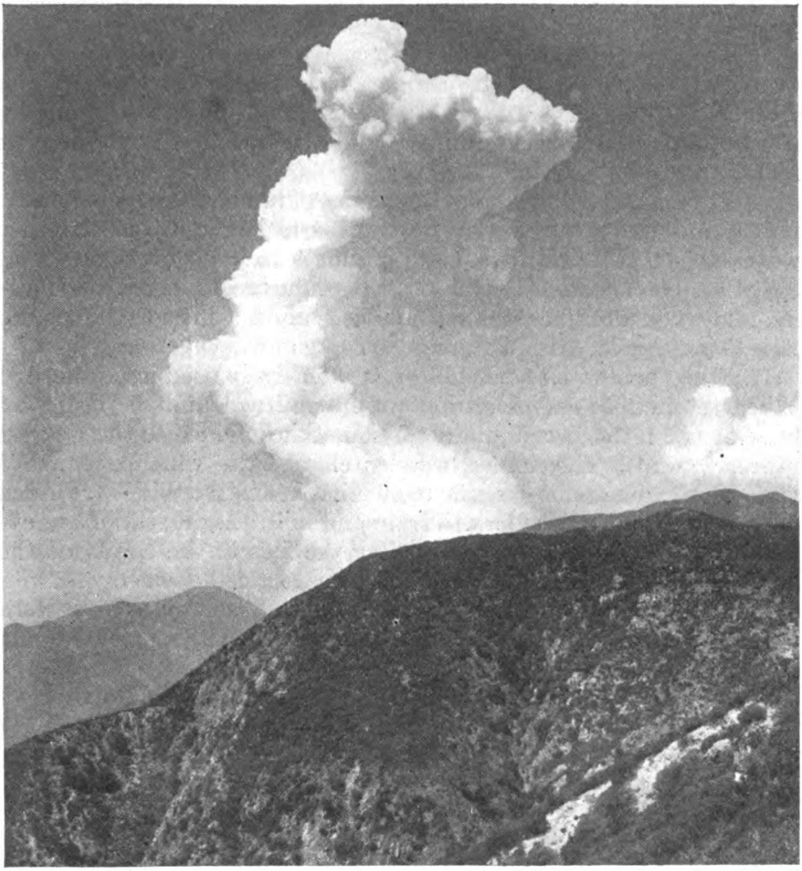

Photo by C. C. Pierce.

FIG. 120.—A forest fire.

various industries employ in the United States about 500,000 persons and have an invested capital of more than $1,000,000,000. The value of the output of the forest products in this country is more than $1,000,000,000 annually.

In the New England and the Lake States most of the timber is cut during the winter, partly because it is easier and cheaper to move the logs on sleds than on wagons, and in part to have the logs ready to float down the streams with the spring freshets. The cost of the transportation within the forest is reduced by having roadbeds of ice. These are made by sprinkling the roads and allowing the water to freeze.

The logs, marked with the owner's sign, are hauled to the banks of the streams, and with the coming of high water "driven" to the saw-mills, which are often located where water-power is available. Bangor, Auburn, Lewiston, Augusta and St. Paul are important saw-mill centers.

From the Lake region great quantities of lumber are sent by boat, the Great Lakes affording cheap transportation, and this, together with the fact that this region still produces 15 per cent. of our total cut of lumber, accounts for the location of the great lumber distributing and wood-working centers, such as Duluth, Chicago, Cleveland, Erie, Tonawanda, Grand Rapids and Saginaw.

On the Pacific Coast machinery is extensively used in lumbering. When the lumber camps are far from a railroad and the mills are close at hand, the sawed product is sometimes flumed to the nearest railroad point. The flumes, wooden channels in which streams of water flow, are in some cases 50 to 60 miles in length. Slides are much employed in getting the logs to train and mill. Light stationary engines, known as donkey-engines, drag the logs to the heads of the slides. Here they are made into *trains* and hauled down by heavier engines situated at the bottom. In California, as well as in western Oregon and Washington, there are many mills capable of cutting 100,000 board feet per day.

Production.—Both production and consumption of lumber have been rapidly increasing in this country.

TABLE 18.

LUMBER CUT OF THE UNITED STATES, 1880-1916, IN ROUND NUMBERS.

1880	18,000,000,000	board feet
1890	23,500,000,000	" "
1900	34,700,000,000	" "
1910	40,000,000,000	" "
1911	37,000,000,000	" "
1912	39,000,000,000	" "
1913	38,000,000,000	" "
1914	37,000,000,000	" "
1915	37,000,000,000	" "
1916	39,000,000,000	" "

In 1910 we were using 260 cubic feet of wood per capita yearly. The lumber cut has increased more than 100 per cent. since 1880. In Europe the annual consumption averages about 50 cubic feet per capita.

New England was originally almost entirely forest-covered. She possesses numerous streams down which timber can be floated. In these streams there are many falls, thus making available cheap power for sawing. These conditions, together with the numerous indentations along the coast, and the opportunities for fishing off shore, led to shipbuilding. The surface features of the area discourage agriculture on a large scale. For all of these reasons lumbering early assumed much importance in New England.

The growing demand for lumber at home, as well as the European market, caused a heavy drain upon the forest, the margin of which was steadily pushed back from the eastern coast. About the year 1870 the supremacy of this region as a producer of lumber passed to the group of states around the Great Lakes. This section was heavily timbered, the path which the center of population has followed in its westward movement crosses the southern part of it, and the Great Lakes furnish an unsurpassed waterway for the shipment of the lumber. This waterway, the vast mineral resource of the lake district, and the fertile prairies to the south combined to develop great centers of population on and near the shores of the lakes. A large demand for lumber in its various forms was thus created. Chicago became the greatest lumber market in the world, and a consumer of vast quantities of wood in the manufacture of vehicles and farming implements.

TABLE 19.

GEOGRAPHICAL DISTRIBUTION OF LUMBER PRODUCT OF THE U. S.[1]

Year	Northeastern States	Lake States	Southern States	Pacific States
	Per cent.	Per cent.	Per cent.	Per cent.
1850	54	6	13	3
1860	36	13	16	6
1870	36	24	9	3
1880	24	33	11	3
1890	18	36	15	7
1900	16	27	25	9
1910	9	15	43	18
1915	5	15	50	18

[1] "The Timber Supply of the United States." Forest Service Circular 97, p. 4. (Except data for 1910 and 1915.)

Soon after 1900 the Southern forest belt took first place in the production of lumber, her output in 1907 being about 35 per cent. of the total output of the United States, and in 1915 about 50 per cent. The South has nearly reached the maximum of her production, and only the Pacific Coast States will in the future show any considerable increase.

Kinds.—Coniferous timber is generally classed as soft wood, and deciduous as hard wood. This is not strictly accurate, however. In the New England area the chief timber is now spruce and hemlock; in the Lake region, white pine; in the Southern forests, yellow pine and cypress; and in the Pacific Coast area, Douglas fir and redwood. The hardwood forests of the United States are found in the Appalachian section from Maine to Alabama, and in the Lake States. The only state outside of these areas that produces hardwood in large quantities is Arkansas.

In Norway, Sweden and Russia from 75 to 80 per cent. of the forest area is coniferous. Hungary, Germany and France have extensive hardwood forests. The forests of India are almost entirely hardwood, but the trees differ from those of the temperate zone. Teak sandalwood and ironwood abound.

For a long time white pine was the chief lumber used in the United States. In 1915 it ranked fourth, contributing only about 7 per cent. of the total cut. Table 20 shows the rank of the most important kinds of wood in the United States in 1915.[2]

TABLE 20.

Kinds of Wood	Rank in 1915	Per cent	Cut in Board Feet
Yellow Pine	1	40	14,700,000,000
Douglas Fir	2	12	4,400,000,000
Oak	3	8	3,000,000,000
White Pine	4	7	2,700,000,000
Hemlock	5	6	2,200,000,000
Spruce	6	3.5	1,400,000,000
Western Yellow Pine	7	3	1,200,000,000
Cypress	8	2.9	1,100,000,000
Maple	9	2.4	900,000,000
Red Gum	10	1.8	650,000,000

[2]Data obtained from Forest Service, U. S. Dept. of Agriculture.

TABLE 21.

RANK OF CHIEF TIMBER-PRODUCING STATES FOR DATES GIVEN

	1880	1890	1900	1910	1915
1.	Mich.	Mich.	Wis.	Wash.	Wash.
2.	Penn.	Wis.	Mich.	La.	La.
3.	Wis.	Penn.	Minn.	Minn.	Miss.
4.	N. Y.	Minn.	Penn.	Ore.	N. C.
5.	Ind.	Wash.	Ark.	Wis.	Ark.
6.	Ohio	N. Y.	Wash.	Texas	Texas
7.	Me.	Texas	Ga.	Ark.	Ore.
8.	Minn.	Ind.	N. C.	N. C.	Ala.
9.	Ga.	Ala.	Texas	Mich.	Va.
10.	Ala.	Ga.	Miss.	Va.	Wis.

Uses of Timber.—While timber is used for many purposes, lumber and fuel are the two most important. Tremendous quantities are used in the making of shingles, laths, crossties, cooperage stock, wood pulp, mine supports, fence posts, poles, furniture, vehicles, farm machinery, boxes and barrels. The United States uses more than 135,000,000 crossties annually. Owing to the lack of oak timber on the Pacific Coast, oak crossties are imported from Japan. In 1914 the amount of timber used in the manufacture of pulp amounted to more than 4,000,000 cords, nearly one-half of which was spruce. It would require all of the spruce on several thousand acres of land to supply any one of our largest daily newspapers with pulp for a year. During the year of 1915 more than 4,000,000 poles were used by telephone, telegraph and electric light companies. Cedar and chestnut are the chief trees drawn upon for this purpose. For fence posts cedar and locust are generally used. Hickory enters largely into the construction of vehicles, while maple and oak are largely used in making furniture and as flooring. The great furniture centers in our country are: New York, Chicago, Grand Rapids, Saginaw and Philadelphia.

Our Trade in Lumber.—We export vast quantities of lumber, the chief countries buying from us being Canada, the United Kingdom, Argentina, Australia, Netherlands, Germany, Mexico, Cuba, Belgium and France. From San Francisco, Portland and Puget Sound ports redwood and Douglas fir are exported to Australia, Asia and South America.

Although California produces great quantities of lumber, the

San Francisco and nearby markets, as well as the Los Angeles market, are to a large extent supplied from Portland and Puget Sound. This is because the rates by water are much cheaper than those by rail, and much of California's timber is far from the coast. Because

Photo from Gifford Studio, Portland, Oregon.

FIG. 121.—Felling an Oregon cedar.

of high freight rates from California to eastern points, large quantities of second-grade lumber are kept at home and made into boxes to supply the growing home demand.

We import some teak from India, Burma and Siam. That is used in the construction of battle-ships, as it does not corrode the steel. We also buy some ebony from India, and mahogany from the West Indies, Central America and Mexico.

Prices.—Owing to the rapidly increasing demand and the decreasing supply, as well as to a combination of the lumber interests, prices have steadily advanced. The following table shows the approximate average prices per thousand feet in the United States in 1899 and 1915:[2]

TABLE 22

	1899	1915
Yellow pine	$8.46	$12.41
Douglas fir	$8.67	$10 59
White pine	$12.69	$17.44
Hemlock	$9.98	$13.14
Western pine	$9.70	$14.32
Spruce	$11.27	$16.58
Cypress	$13.32	$19.85
Redwood	$10.12	$13,54
Oak	$13.78	$18.73
Walnut	...	$48.47

Future of the Lumber Supply.—So great is the quantity of lumber consumed annually, that the future supply for this and for all other countries is a question of grave importance. A century ago it seemed as though our supply was inexhaustible, while today a shortage stares us in the face. We are steadily consuming our forest capital, for in the United States we are using the timber three or four times as fast as it grows. Unlike other crops, the timber crop is very slow to mature. In California sugar-pine trees two hundred years old average about thirty-two inches in diameter breast high, and are about 144 feet in height. Yellow pines of the same age average about thirty inches in diameter breast high, and are about 132 feet high. Our Forest Service tells us that the average age of trees cut in the United States in 1906 was about one hundred and fifty years.

At the annual meeting of the Northern Pine Manufacturers' Association, held in Minneapolis, January 22, 1907, the Secretary, Mr. J. E. Rhodes, said: "Since 1895, 248 firms, representing an annual output of pine lumber of 4½ billion feet, have retired from business, due to the exhaustion of their timber supply. Plants representing approximately 500 million feet capacity which sawed in 1906 will not be operated in 1907."

This statement is very suggestive of the growing scarcity of timber. Trees are now being felled which, a few years ago, would have been rejected by the lumberman, and much material of a character

[2] Figures obtained from the Forest Service.

formerly wasted is now being utilized. The use of brick, stone and plaster and concrete in house-building, of steel in ship-building, of wire in fencing, as well as creosote treatment of posts, poles, piling and crossties, are all helping to conserve our failing timber supply. The scientific management of existing forests, and the reforestation of burned, logged, and other areas, is the solution of the lumber problem.

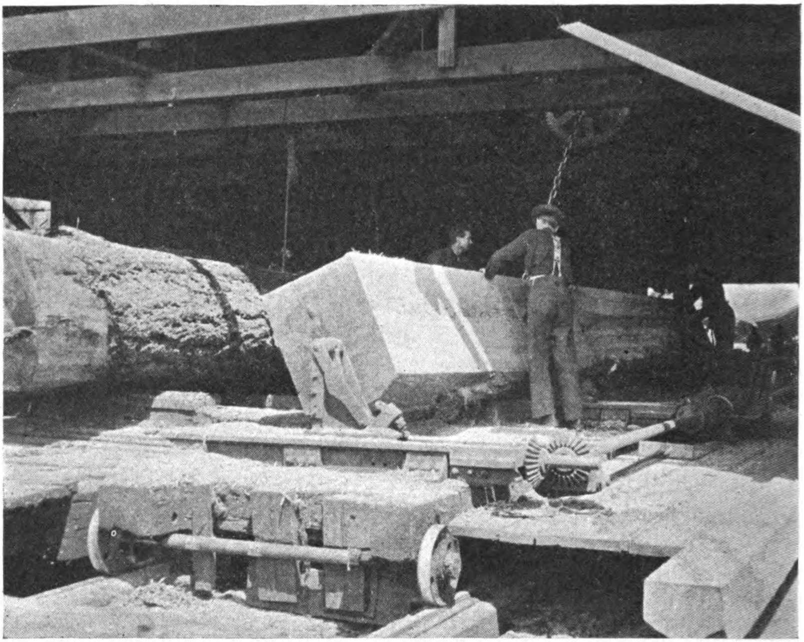

Photo by Chamberlain.

FIG. 122.—A saw mill.

RUBBER

General Statement.—It was in the West Indies that rubber first came to the attention of Europeans. This led to the use of the term *india* rubber. When Columbus visited Haiti he observed the natives playing with rubber balls. In the eighteenth century Priestley, an English chemist, discovered that rubber could be used to erase pencil marks. Its value as applied to clothing was not discovered until much later.

Most of the rubber of commerce is the product of the *latex* or milky juice of the rubber tree, of which there are several varieties.

The Para or *Hevea Braziliensis*, the Central American or *Castilla elastica*, and the India or *Ficus elastica*, are the most important.

There are hundreds of latex-yielding plants, the milkweed and the poppy being among the number. A shrub called guayule, which grows in the dryer parts of Mexico, produces a fairly good rubber. In the latex of the rubber tree there are many minute globules of resin and caoutchouc, the latter being the substance from which rubber is produced.

The rubber tree grows to a height of 60 or more feet, and sometimes attains a circumference of 10 feet. The leaves are three-lobed. When the seed are ripe, the hot sunshine causes the capsules to burst with a report, and the seed are scattered in all directions.

Distribution.—The Amazon valley is the chief source of the world's supply of rubber. Bolivia, Peru, Central America, Mexico, India, Ceylon, Madagascar and equatorial Africa produce considerable. The rubber tree does not flourish in any region where the temperature falls below 60° F. at any time of the year, and it does best where the mean temperature is about 80° F., and the rainfall from 80 to 100 inches per year. Contrary to the belief held formerly, the rubber tree does not require a marshy soil.

Processes.—The latex is obtained by tapping. Various methods are employed, the "herring-bone" being the most common. On either side of a central incision made parallel to the axis of the tree a number of incisions are made, which unite with the central one at an angle of 45°. This tapping covers practically one-half of the tree. A short tin spout leads the latex from the lower end of the main incision into a cup or other receptacle. Workmen visit the trees daily, and empty the contents of the cups into larger vessels. Trees are not usually tapped until they are four years old. A tree will yield about ten pounds of rubber yearly. Careless and too frequent tapping has destroyed many trees.

The collectors carry the latex to the camp, where it is poured into large caldrons under which are fires made of palm nuts. The smoke from the burning nuts causes the rubber to coagulate about wooden paddles which the workmen dip into the caldrons.

As a result of repeatedly dipping the paddle into the caldron and holding it in the smoke, a considerable quantity of rubber forms about it. After being thoroughly dried, these pieces of rubber, called "hams" or "biscuits," are removed from the paddles, and are then ready for exportation.

When the crude rubber reaches the factory it is placed in tanks containing warm water; this softens it so that it can be cut up and run between rollers. Water falling upon the rubber while it is be-

FIG. 123.—Gathering rubber. Honduras.

tween the rollers frees it from leaves and dirt. Much of the plantation rubber is sufficiently clean to make washing unnecessary, but most of the world's supply yet comes from uncultivated forest trees.

In 1823 Mr. Mackintosh first made the garments which were given his name. This was accomplished by dissolving the rubber in a liquid such as turpentine. On the evaporation of the liquid the rubber was left in the form of a film. This was spread on cloth, thus *water-proofing* it.

As rubber is readily affected by high and low temperatures, its use in the manufacture of clothing was not very satisfactory until after the process of vulcanizing was discovered. This was worked out independently by Mr. Goodyear in America in 1839, and by Mr. Hancock in London. The method commonly employed is that of mixing rubber and powdered sulphur, and heating the mass out of contact with the air.

Uses.—India-rubber is used in many ways, the most common being the making of rubber boots, rubbers, overshoes, mackintoshes, hats, rubber bands, toys, tubing, waterproof cloth, printing rolls, stamps, stoppers, tires for bicycles and automobiles. About one-third of the crude rubber is used in the making of boots, rubbers and overshoes. The increased use of automobiles has very greatly increased the demand for rubber.

Exports.—The larger part of the crude rubber of the world is exported from the Amazon valley. Para, which is situated close to the mouth of the Amazon, is the great exporting center. For the three years ending with 1915 approximately 16 per cent. of the total value of Brazil's exports was in the form of rubber. The average value of the rubber exported for the same period was about $40,000,000. Since 1910 there has been a great increase in the value of the rubber exported.

More than one-half of the exports of Brazil go to the United States, and the remainder to Europe. Both London and Liverpool receive large quantities. Owing to destructive methods employed in tapping, and to increased demand, the prices of rubber have risen greatly during recent years. For the three-year period ending with 1915 the average price of the rubber imported by the United States was about 60 cents per pound.

Gutta-Percha.—Gutta-percha is quite similar to rubber. It is produced in the East Indies, Malay Peninsula and the Philippines; Singapore being the chief exporting point. In obtaining gutta-percha the trees are usually cut down instead of being tapped while standing. The milk, which soon thickens and hardens, is placed in boiling water. This softens it so that it can be worked in any form desired. It is freed from bark, sand, chips and other impurities by being ground in water. It is then rolled into thin sheets or balls, and pressed. No other plastic substance possesses as great electrical resistance as does gutta-percha. It retains this quality when used underground and in water. Because of this it is ex-

FIG. 124.—Tapping for turpentine. (Courtesy of the U. S. Forest Service.)

tensively employed as an insulating medium for submarine and underground cables. It is also used in the manufacture of hose, buckets and bottles.

Turpentine.—The turpentine industry is one of considerable importance in our Southeastern States, in France, Russia, Austria and Scandinavia. In the spring, when the sap begins to rise in the trees, the work of tapping the trees and collecting the crude turpentine begins. The methods formerly employed were very destructive, and large areas of yellow pine, the tree which furnishes most of the turpentine, were ruined. The crude product is distilled, and thus the turpentine of commerce is obtained.

Our Bureau of Chemistry has carried on investigations which have shown that all of the turpentine needed in this country can be made from dead trees, stumps and sawdust. If this waste material were utilized it would result in a great saving to our forests. The United States is the world's greatest exporter of spirits of turpentine, shipping to other countries in the year ending June 30, 1915, about $4,500,000 worth. The exports during 1915 were far below the average, which for the five-year period ending with 1915 was more than $8,000,000.

The turpentine industry in our country is moving southward, and is now important in the Gulf States. The product is shipped from Wilmington, North Carolina, Charleston, Tampa, Mobile and New Orleans. Turpentine is extensively used in paints and varnishes. It facilitates drying through the formation of ozone.

Rosin.—In the process of distilling, the spirits of turpentine is carried off in the steam, after which it is recovered through condensation, and a solid substance called rosin is left behind. It is used in the manufacture of soaps and varnishes, in sizing paper, in soldering, and on violin bows. The United States exports more rosin than do all other countries combined.

Pitch, Tar and Creosote.—Through the distillation of wood, a black substance known as pitch is obtained. When this is boiled down, tar results. These substances are used in caulking vessels and in the manufacture of tarred paper. Creosote, used to preserve posts and pilings, is also a product of pitch.

Tanbark.—In the tanning of leather the bark of certain trees, the hemlock and oak particularly, is extensively employed. The tannic acid which the bark contains penetrates the pores of the leather, hardening it and rendering it durable. Owing to the bulk of the bark, its shipment is not economical, and our great shoemaking centers have therefore been located close to the forests. In recent years the acid has been extracted from the bark, thus making it unnecessary to have the leather and shoe industry so strictly localized.

Cork.—The world's supply of cork comes very largely from Spain, Portugal and Algeria. In Spain and Portugal the trees are cultivated, but in Algeria there are as yet only natural forest trees. The first growth of bark on most trees is of a corky character, but the cork of commerce is obtained from the bark of an evergreen oak. When the trees are about 15 years old the bark is first removed. This first cutting, which is called *male bark*, is of no commercial value. Later cuttings occur at intervals of 8 or 10 years for 100 years or more.

After the cork has been removed from the tree, it is pressed into sheets, and then placed in boiling water. Through the process of boiling, the cork becomes much more elastic and its bulk is increased. The sheets are shipped in bales.

Cork is used in making stoppers for bottles, floats for nets, life preservers, and as inner soles for shoes.

There are many other products of the forest of considerable value, such as quinine, camphor, spices and flavors.

STUDIES

What European countries import lumber? How long will our timber supply last? How does the value of our forest products compare with the value of our agricultural products? Make a list of the industries which draw upon the products of the forests. What is the chief building material in your locality? About how much rubber is required in the United States yearly by the automobile industry?

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PART FOUR

ANIMALS IN THEIR RELATION TO MAN

CHAPTER XXV

Animals as Sources of Food

General Statement.—Without the aid which man receives from both wild and domesticated animals, his life would be very different from what it is today. When man learned to domesticate animals and make them his servants, he made a great advance in civilization. Animals furnish material used as food, clothing, in the construction of rude habitations, as ornaments, and they are exceedingly valuable in the transportation of people and commodities and in the tilling of the soil.

Until comparatively recently the food products of animals, being perishable, did not enter largely into commerce. Formerly those products were used by the owners of the animals from which they were obtained, or they were bartered or sold to people living close at hand. Division of labor and the growth of population, especially great cities, made commerce in these commodities a necessity.

Rapid means of transportation, refrigeration, and various forms of preserving these perishable articles have solved the problem. No longer does a community or nation have to produce its own food or other necessities of life. Great Britain furnishes an excellent illustration of this. The people, taking advantage of their vast mineral wealth, of the short distance between interior points and the coast, of their favorable commercial position and of their large population, are devoting themselves primarily to industry and commerce, and depend very largely upon the outside world for food and clothing. Australia, New Zealand, South Africa, Canada and the United States are among the countries which supply animal products to Great Britain.

The Meat Industry.—In most parts of the world meat is an important food. Beef, mutton and pork are the meats chiefly used, although the flesh of many other animals is utilized.

The great cattle ranches of the world are located where there are vast areas of uncultivated land. There must be sufficient precipitation to insure pasturage. Comparative freedom from snow is a favorable condition, as this enables stock to secure at least a part of their living out of doors during the winter. These conditions exist in the western part of the United States, Argentina, Uruguay, Paraguay, Australia and Canada, and these countries are exporters of beef and mutton.

In our country the cattle industry has been steadily pushed westward as settlement has increased and the price of land advanced. In the Southwest the winters are not so severe as they are in the Northwest, where blizzards occasionally occur. The Chinook winds, being relatively warm and very dry, cause the snow to evaporate rapidly in this northwest section, and hence cattle forage considerably during the winter.

A productive farm can support several times as many cattle as can be supported on the same area of uncultivated land. Because of this, about 45 per cent. of the cattle in the United States are found in the Middle Western States. Many of these are dairy cows, and many are cattle which have been taken from the Western ranges into the corn belt to be corn-fed for market.

TABLE 23.

AVERAGE NUMBER OF CATTLE FOR THE FIVE-YEAR PERIOD ENDING WITH 1915.[1]

State	Round numbers
Texas	6,200,000
Iowa	4,000,000
Nebraska	3,300,000
Wisconsin	2,600,000
New York	2,500,000
Kansas	2,300,000
Minnesota	2,250,000
Illinois	2,200,000
Missouri	2,200,000
Ohio	1,700,000
United States	54,600,000

The cost of beef in our country has increased during recent years. One reason for this is found in decreasing pasturage. Since 1840 the population of the United States has increased more than 500 per cent., but the number of cattle has increased only 400 per cent.

The average annual value of our expor ation of beef and beef products for the five-year period ending with June 30, 1916, was in round numbers $32,000,000. Between the years 1901 and 1914 there was a great decrease in the amount and value of our exportation of beef. The war demand caused an enormous increase in exportation. Argentina now holds the place fo merly occupied by the United States as an exporter of beef. A part of our export is shipped as

[1]Yearbooks, U. S. Department of Agriculture.

chilled beef, a part on the hoof, and a part canned. The British Isles, France and Germany are our largest buyers of fresh beef. Much beef is exported from Australia to the British Isles.

As sheep can secure pasturage where cattle cannot, many semi-arid parts of the world raise large numbers of sheep. Australia, South Africa, Spain and some of our Southwestern States are illustrations. One herder with a dog can take care of a very large number of sheep, which reduces the cost of producing mutton.

FIG. 125.—Cattle ranch. Canada.

Through scientific breeding the quality of the mutton has been greatly improved. Large quantities of this meat are exported from Australia and New Zealand to the countries of western Europe.

TABLE 24.

AVERAGE NUMBER OF SHEEP FOR THE FIVE-YEAR PERIOD ENDING WITH 1915.[2]

State	Round numbers
Montana	4,800,000
Wyoming	4,700,000
Ohio	3,450,000
New Mexico	3,200,000
Idaho	3,000,000
Oregon	2,600,000
California	2,500,000
Michigan	2,200,000
Texas	2,000,000
Utah	2,000,000
Missouri	2,000,000
United States	51,400,000

[2]Yearbooks, U. S. Department of Agriculture.

Swine, not requiring the range that is necessary for cattle and sheep, are raised in large numbers in many densely populated parts of the world. In European countries they are fed to some extent upon nuts, acorns and sugar-beet refuse, but in our country corn is the chief food, and most of the hogs are found in the corn belt. In our Western States the growing of alfalfa and the raising of hogs are very commonly associated.

The chief hog-raising countries of the world are: the United States, Germany, Austria-Hungary, European Russia, France and the United Kingdom. As many hogs are raised in the United States as in all the other countries named.

The slaughtering and meat-packing industry affords investment for a vast amount of money, and employment for hundreds of thousands of persons. The work is highly specialized. In the United States our greatest meat-packing centers are in or near the corn belt. Chicago, St. Louis, Kansas City, Omaha, St. Joseph and St. Paul are the most important.

In many cases animals are inspected before being killed, and if not found to be in a healthy condition are rejected. Government officials, both in the United States and in some foreign countries, inspect the meat offered for sale, and stamp it to show that such inspection has been made.

The Dairy Industry.—Milk is an article of food used in every part of the civilized world. The milk of goats, camels, reindeer and asses is used to some extent, but that of the cow is of primary importance. Milk is secreted from the blood, and on the average contains about 87 per cent. of water, nearly 4 per cent. of fat, 2.5 per cent. of casein, 0.7 per cent. of albumen, 5.1 per cent. of milk-sugar, and 0.7 per cent. of ash. The scientific breeding of cattle has given us a larger yield of milk per cow, and a better quality as well.

The securing of a supply of fresh and pure milk for our large cities is a very important matter. London, Paris, New York and other large cities obtain milk from points many miles away. This was not possible before the days of the railroad. Shipment of milk in cans has in large part given place to shipment in bottles. This means an increase in cost, but a purer supply. Condensed milk and cream are very important in situations where the natural products cannot be obtained.

As a result of the former careless methods used in handling milk, dust and dirt found its way into it. This meant the introduction of bacteria also. The bacteria change the milk-sugar to acid, and hence cause the milk to sour. By heating milk to a temperature of 60° to 70° C. (140°-157° F.) and holding it at this temperature for 20 minutes, the bacteria are destroyed. The milk is then rapidly cooled. The process, which is called *pasteurization*, after Pasteur, its inventor, increases the keeping quality of milk. In 1893 Mr. Nathan Straus,

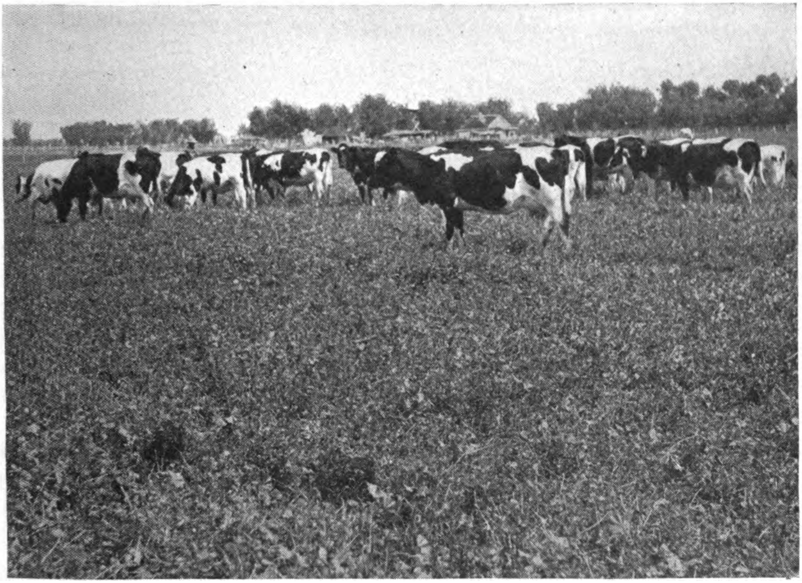

Photo by M. L. Gibbons.

FIG. 126.—A dairy farm.

the well-known philanthropist, began the pasteurization of milk in New York City in order to reduce the death-rate among infants. During all of these years the milk has been distributed at a loss. Mr. Straus has given large sums for the same great work in many cities in this and other countries. The milk sold in most of our cities and towns is tested, usually under the direction of Boards of Health. The test is of great value to the producer as well as to the customer, for by testing the milk of each cow the dairyman knows which ones are not profitable to him.

Naturally those areas, so situated as to be able to supply the large cities are the chief producers of milk if they have the necessary pasturage, or the feed of other kinds.

TABLE 25

CHIEF MILK-PRODUCING STATES IN OUR COUNTRY IN 1910.[3]

State	Gallons (round numbers)
New York	597,000,000
Wisconsin	458,000,000
Pennsylvania	336,000,000
Illinois	320,000,000
Iowa	318,000,000
Ohio	307,000,000
Michigan	283,000,000
Minnesota	273,000,000
Texas	197,000,000
Indiana	194,000,000

Butter.—The fat in milk is in the form of very minute globules. The fat, being lighter than the milk, rises to the surface of the receptacles in which the milk is contained, forming *cream.* The old-fashioned method was to skim off the cream and churn it. The invention of the separator has revolutionized the dairying industry. The separator is in effect a great bowl into which the milk is placed, and which revolves several thousand times a minute. Centrifugal force throws the fat to the center, and it escapes from an opening in the cover. The milk is drawn off from the edge of the bowl. By this process from 97 to 98 per cent. of the fat is saved.

The farmer delivers his milk to the creameries. Here it is put through the separator, and the so-called skimmed milk is carried home and fed to hogs or calves. The butter is made at the creameries and shipped to the cities. Under our Pure Food Law butter must contain 82.5 per cent. of fat, and must not exceed 16 per cent. of water.

TABLE 26.

AVERAGE ANNUAL EXPORTATION OF BUTTER FOR THE FIVE-YEAR PERIOD ENDING WITH 1913.[4]

Country	Pounds (round numbers)	Rank
Denmark	195,530,000	1
Russia	150,093,000	2
Australia	77,858,000	3
Netherlands	75,132,000	4
Sweden	46,567,000	5
France	41,682,000	6
New Zealand	38,760,000	7
Finland	26,337,000	8
World	690,645,000	

[3]Statistical Abstract of the Thirteenth Census, 1912, p. 179.

[4]Yearbooks, U. S. Department of Agriculture, 1913 and 1914.

Cheese.—Canada leads the world in the exportation of cheese. The Netherlands rank second, and Switzerland, New Zealand and Italy export large quantities. As an importer, the United Kingdom is far in the lead, but Germany, the United States, Belgium and France are large buyers. The first cheese factory in the United States was established in Oneida County, New York, in 1851.

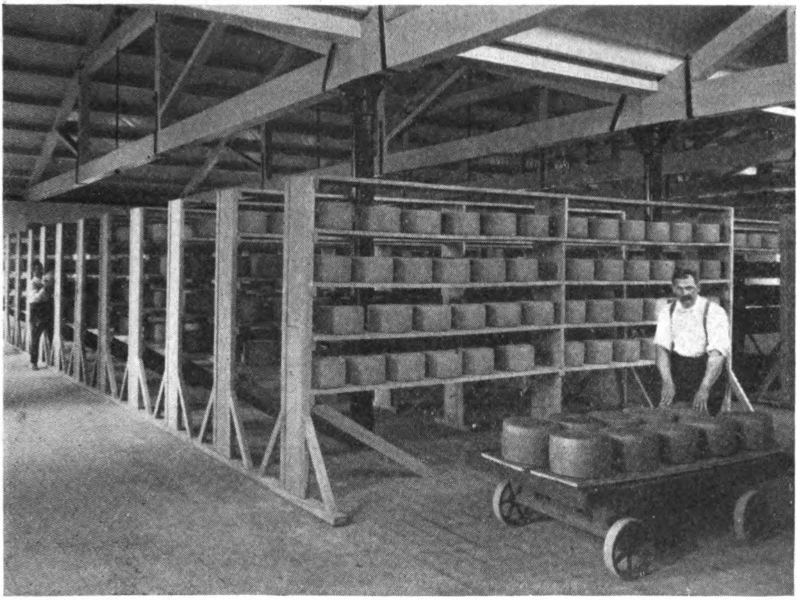

FIG. 127.—A cheese factory in Victoria, Australia. (Courtesy F. T. A. Fricke, Victoria.)

TABLE 27.

LEADING CHEESE-PRODUCING STATES IN 1914.[5]

State	Pounds (round numbers)
Wisconsin	206,000,000
New York	97,000,000
Pennsylvania	15,000,000
Michigan	13,000,000
Ohio	9,000,000

[5] Statistical Abstract of the United States, 1917, p. 164.

The Poultry Industry.—There are few farms in this or in any other country on which some poultry is not kept. In addition, many fowls are raised in towns and cities. Although chickens are the most numerous and the most valuable, ducks, turkeys, geese and other fowls are raised in large numbers.

FIG. 128.—The farm flock—White Plymouth Rocks.

Formerly poultry-raising was entirely incidental to farming. Today it is a regular industry. Owing to rapid transportation and refrigeration, both poultry and eggs are now shipped long distances. This is illustrated by the shipment of eggs from Argentina to England, and from China to the United States. Eggs and poultry are placed in cold storage when better prices are desired. In our country the Central States are the chief producers of poultry and poultry products.

TABLE 28.

POULTRY AND EGGS IN THE UNITED STATES.[6]

Date	Fowls	Eggs (in dozens)
1880	125,500,000	457,000,000
1890	285,000,000	820,000,000
1900	250,000,000	1,000,000,000
1918 [7]	589,000,000	1,921,000,000

The total farm value of the poultry and eggs produced in our country in 1914 was about $550,000,000. This is about six times the value of all of the gold mined in the United States during the same year; about five times the total value of our sugar output; more than four times the value of the barley; more than two and one-half times the value of the potato crop; more than the value of the oats; and it nearly equals the value of our wheat crop.

THE FISHING INDUSTRY

Fish.—The sea, as well as the land, yields valuable harvests of food. For thousands of years people living near the sea have turned to it for a part of their food supply. Fish depend in large measure upon plant life for food. As few plants grow in deep water, and as plant and animal life washed into the sea from the land are most abundant near shore, it is here that fish exist in greatest numbers. Some fish, such as the cod, eat smaller fish. A given fish has a relatively small vertical range of habitat, owing to the rapid increase in pressure with increase in depth.

Land animals which are raised for food require much care, but fish in their natural state do not. For this reason fish, generally speaking, is cheaper than meat. Although the number of fish in the sea is enormous, long-continued and destructive methods of fishing have greatly reduced the numbers in some cases. This applies particularly to fish that ascend rivers to spawn. Our government and that of some other countries, notably Japan, have established departments for the scientific study of the fishing industry.

Waters more than three miles from the coast of a country are free to all. Within this limit the right to fish is restricted to the people of the given country. The necessity for food on the part of the nations of western Europe led fishing vessels to the Grand Banks before the year 1500. With the discovery of northeastern America the importance of Newfoundland and adjacent areas as drying-

[6] United States Census Reports, 1910.

[7] Estimate Yearbook, U. S. Department of Agriculture, 1918, p. 13.

grounds for the fish became apparent. This led to much friction between England and France, and later to troubles between England and her colonies. Indeed, as late as 1912 it was necessary for the United States and England to enter into a new treaty.

The United States, the British Isles, Norway, France, Canada and Japan are among the most important fishing nations. The Shetland Islands, north of Scotland; the Dogger Bank, northeast of Hull, England; and the Grand Banks are important cod-fishing

Fig. 129.—Taking a large Chinook salmon from a seine in the Columbia River. (U. S. D. A.)

grounds. From early days the fishing industry was important in New England. The States are relatively close to the Banks, the people lived near the coast, and conditions were not very favorable for agriculture. "So thoroughly did the colonists recognize the importance of the fishing industry that the legislature of Massachusetts hung in the hall of representatives of their state capitol a wooden representation of a codfish; moreover, they hung it where the eyes of the Speaker could always see it, so that he might keep in mind the most important interest of the people of the community."[8]

The people of New England sold large quantities of a very poor quality of fish to the slave owners in the West Indies. The New England ships carried home cargoes of molasses, which commodity

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[8]Moore: "Industrial History of the American People," p. 33.

was at great profit converted into rum. Much of this rum was used in the purchase of slaves on the West Coast of Africa. This is a striking illustration of the ways in which the fishing industry has been connected with the history of the world.

At the present time (1917) the value of our annual catch of fish is nearly $50,000,000. The Japanese hold high rank in the fishing industry. The catch of several other nations is more valuable, but in no other country is so large a proportion of the total population engaged in the industry. The proximity to the sea, their very extensive coast-line, their large population and the relatively small area of tillable land are factors which increase the importance of fishing.

One of the chief food fishes is the salmon. Formerly these fish were abundant in the North Atlantic, but they are now greatly reduced. The salmon fishery is important from the Sacramento River northward, the southeastern coast of Alaska being the chief fishing grounds. The protected bays at the mouths of the streams up which the salmon go to spawn furnish excellent opportunities for fishing, for the establishments of canneries and salteries, and afford deep water for the anchorage of vessels. Destructive methods are reducing the numbers here also. It is of the greatest importance that the fish be not prevented from ascending the rivers to spawn, for if they be prevented from doing so, there will be no future supply of the fish in the streams. It is an interesting fact that none returns alive to the ocean after spawning.

The cod is a fish of great value. As it inhabits relatively deep water, it is caught by means of hook and line only. When the fishing grounds are reached, men in small boats called *dories* set the lines, to each of which a large number of hooks are attached. At intervals the lines are pulled up, the fish taken off, and the hooks rebaited. This is known as *trawl* fishing.

The herring is a very important fish, inhabiting relatively cold waters. There are important fisheries in the United States, Canada, Japan and the North Sea countries. In New England and western Europe herring are canned and sold as sardines.

Along the coast of Brittany the sardine fishery is highly important. The name is derived from the island of Sardinia. Technically there is no such fish as the sardine. The term is most commonly applied to the young of the pilchard.

Other important food fishes are the halibut, mackerel, shad among salt-water fishes, and in fresh water the trout, white fish and sturgeon. The fishing industry on the Great Lakes is of considerable value.

Neither Great Britain nor Germany can supply herself with meat, and hence fishing is an important industry. In 1912 the catch in Great Britain was valued at $64,405,331. Germany encourages the industry by paying a bounty on all fishing vessels built, and by shipping the fish by rail at very low rates.

Oysters.—For 2,000 years oysters have been cultivated in China and Italy. They are now obtained from natural and cultivated

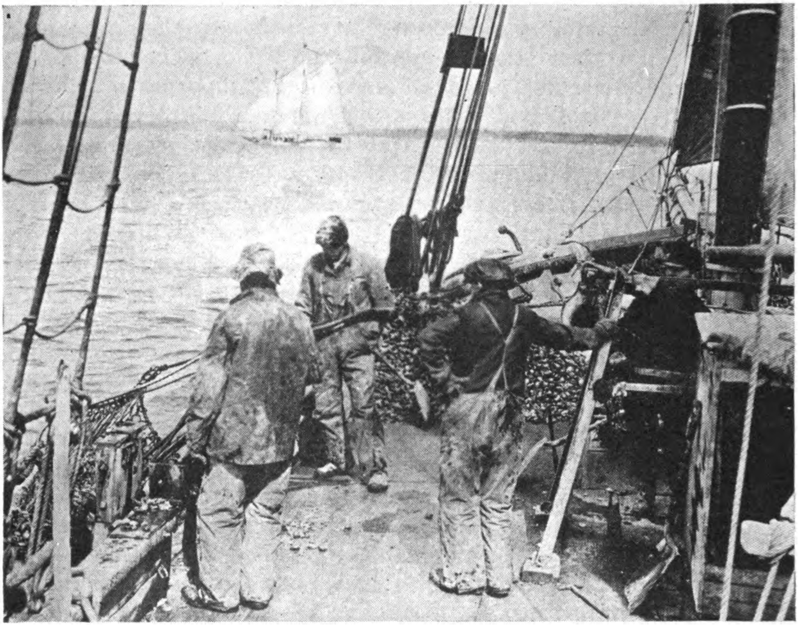

FIG. 130.—Oystering in Chesapeake Bay

beds in many countries, although the United States and France are the most important. The world's annual output is worth about $25,000,000.

More oysters are produced in Chesapeake Bay than in any other similar body of water. Baltimore is the center for this field. Many oysters are produced in New England waters, in the Southern States and on the Pacific Coast. Cancale, near St. Malo, France, depends almost entirely upon the oyster industry.

The oyster belongs to the group *Mollusca*, as does the clam. Except at the very beginning of its existence, it is stationary, and in this respect differs from most animals. It has many enemies, which greatly reduce its numbers. The starfish, black drum and stingray are among the most important.

The oyster farmer covers his fishing grounds with shells, stones or broken crockery, or he arranges trays upon the bottom, or, as in Japan, pushes bamboo poles into the mud. The object in all of these cases is to furnish something to which the oysters can attach themselves. Oysters are harvested by means of dredges drawn behind boats or by hand, using rakes and tongs. From two to four years are required to bring the oyster to a marketable condition.

Lobsters, crabs, snails, turtles and various other sea animals are used as food. The lobster industry is important in Brittany and off the New England coast. Turtles are shipped from Florida to New York and to London.

THE BEE INDUSTRY

For thousands of years honey has been used as a food. References to it are found in the Bible. At first the supplies came from wild bees, but bees are now kept in practically all countries. One who makes a business of bee-keeping is known as an *apiarist*. On many farms bee-keeping is merely an incidental.

In 1909 nearly 55,000,000 pounds of honey and 900,000 pounds of wax were reported as produced in the United States. The total value of the product was about $6,000,000. California far outranks any other state in the value of her honey and wax. Other very important producers are: Texas, New York, Missouri and Iowa.

In the northern and central parts of the United States much buckwheat is sown for bees. East of the Rocky Mountains a great deal of honey is produced from white clover, and in the Western States much sage-honey is made.

The sugar shortage during the World War turned our attention more definitely to honey. The production of this commodity can be very greatly increased. This would materially decrease our importation of sugar.

STUDIES

Where is the world to get its meat supply 100 years from now? Why s the price of meat advancing? What European countries are especially adapted to dairying? Why? What made possible the shipping of meat and dairy products from Australia and New Zealand to the British Isles? What measures have been taken to insure a lasting supply of fish from ocean waters? Are any wild animals in danger of extermination because of their slaughter for food? Is it necessary to conserve meats and fats during times of peace?

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CHAPTER XXVI

ANIMALS AS SOURCES OF CLOTHING

Wool.—The sheep produces a double crop—wool and mutton. Wool is of particular value owing to the microscopic, overlapping serrations on the fiber. Because of these, goods very close in texture can be made. The average length of the fiber is about seven inches.

The merino sheep, which originated in Spain centuries ago, produces the best grade of wool. Through scientific breeding, the yield has been increased and the quality improved. Much merino wool is now shipped from Australia, New Zealand and South Africa. London, Antwerp, Havre, Philadelphia and Boston are very important wool markets.

Formerly all shearing was done by hand, but today machinery is largely employed, as this reduces the cost. When the wool reaches the factories it is thoroughly washed to rid it of dirt and grease. In spite of the fact that our country produces much wool, we import extensively.

TABLE 29.

CHIEF SHEEP-RAISING COUNTRIES [1]

Country and Date	Round numbers
Australia, 1917	76,669,000
Argentina, 1914	43,225,000
United States, 1919	49,863,000
European Russia, 1914	37,240,000
Turkey, 1913	27,095,000
Asiatic Russia, 1914	34,468,000
British Isles, 1918	27,063,000
New Zealand, 1918	26,538,000

A long, white lustrous wool, known as mohair, is obtained from the Angora goat. Turkey, South Africa, Algeria, Argentina, Mexico and Spain are the countries in which the Angora goat is raised in largest numbers. Some are raised in Texas and California.

Leather.—Leather is made by tanning the skins of animals. The bark of the hemlock and the oak furnish an acid which is very valuable in tanning. For this reason tanneries have in the past generally been located close to hemlock or oak forests.

[1] Yearbook, U. S. Department of Agriculture.

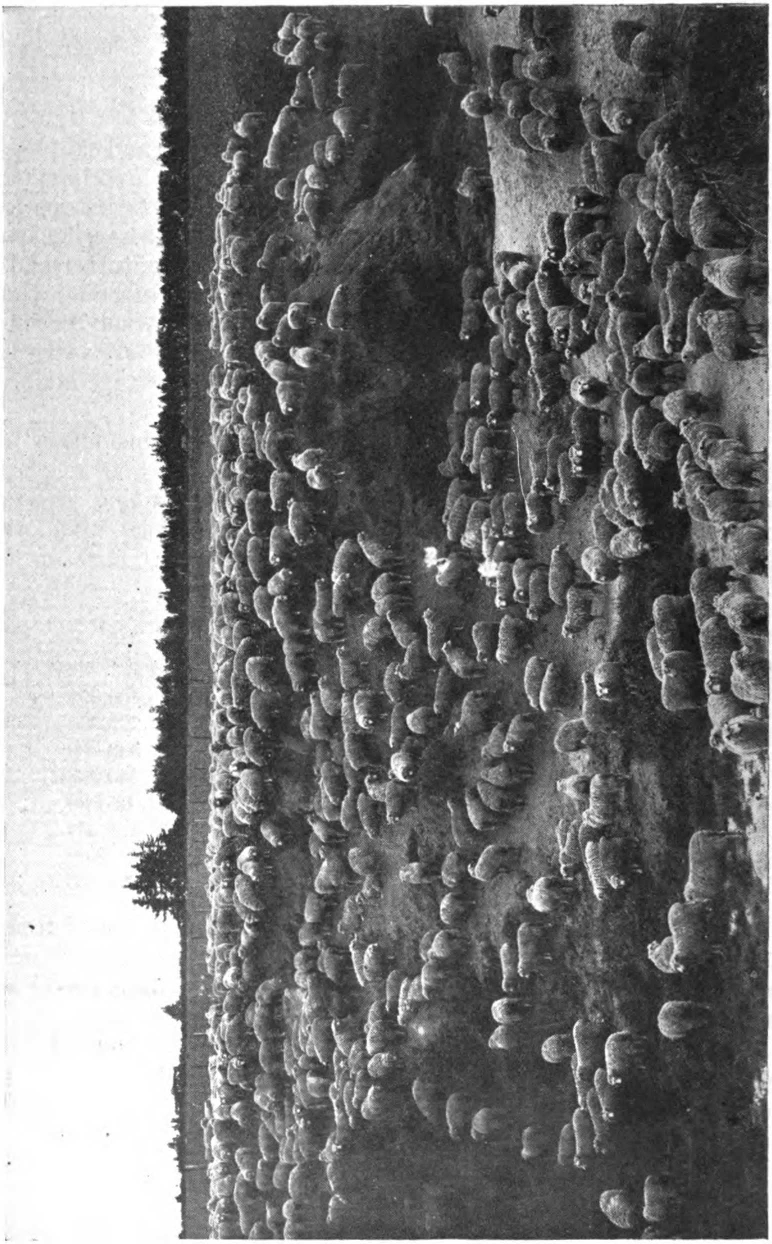

FIG. 131.—Sheep in Tasmania. (Courtesy Immigration and Intelligence Branch, Dept. of Agriculture and Stock, Hobart.)

Skins are soaked in vats containing lime in solution. This loosens the hair so that it can readily be scraped off. The hides are then placed in water in order to remove the lime. The tannic acid enters the pores of the skin and hardens the lower layer, or *derma,* so that it endures wear well. Leather is not dyed as textiles are, but when an artificial color is desired it is put on by means of a brush.

The chief articles of clothing made from leather are boots and shoes. Others less important are gloves, mittens, caps, aprons, belts, coats and satchels. The hides of cattle are employed more extensively than are the skins of other animals, but the skins of horses, sheep, goats, reindeer, dogs and some wild animals are used.

Silk.—The seemingly insignificant silkworm, or silk caterpillar, produces yearly raw silk worth millions of dollars. The first requisite is the mulberry tree, for upon the leaves of this tree the silkworm feeds. Although other leaves are used to some extent, such as those of the osage-orange, nothing else equals the mulberry. The second essential is cheap labor. Both of these conditions are found in China, Japan, Italy and France, which are the chief producers of raw silk.

The Chinese are given credit for having discovered how to manufacture silk goods. The United States now manufactures more silk than does any other country, although we produce little raw silk. About one-half of our raw silk comes from Japan, and about one-half of the silk goods which we import comes from France.

In 1914 there were in the United States 902 establishments for the manufacture of silk goods, and the value of the output during the same year was $254,011,257. Table 30 shows the growth in our importation of raw silk.

TABLE 30.

IMPORTATION OF RAW SILK BY THE UNITED STATES.[2]

Years	Pounds (round numbers)
1870	500,000
1880	2,500,000
1890	7,500,000
1900	13,000,000
1910	23,500,000
1917	40,300,000

[2] Statistical Abstract of the United States, 1917, p. 748.

Paterson, New Jersey, is the world's greatest center for the manufacture of silk ribbons. Lyons, France, is the chief French center for the manufacture of silk goods. Krefeld, Germany, and Milan, Italy, are other important silk-manufacturing centers.

The leaves of the mulberry tree are picked, washed, dried, cut into small pieces, and then fed to the silkworms. The worms are kept on trays in clean rooms having a uniform temperature. Until full grown, the worms are fed several times daily. They live about a month, and when mature are about two inches long, and cream-white in color. They spin the cocoons from which the raw silk is later unwound.

When silkworms are desired, the moths are permitted to hatch from the cocoons.

The moth lays a large number of eggs, about as large as the head of an ordinary pin, and from these the worms hatch. Moths are not permitted to hatch from the cocoons from which silk is to be unwound, because when the moths break from the cocoons the silk is ruined.

Furs.—Both because of their warmth and beauty, furs have been made into articles of clothing for many centuries. Formerly, owing to the low cost, the poor as well as the rich wore furs. Today they are very expensive, because fur-bearing animals have decreased greatly in numbers.

Much of the early history of the United States and of Canada is connected with the fur industry. It was the fur trade of the upper Missouri that led the Frenchman La Clede to establish a post where St. Louis now stands. It was the search for beavers that led people from the East to California.

The Hudson's Bay Company, which was formed in 1670, bought furs of the trappers, and furnished the latter with supplies. This company, which is still in existence, practically controlled affairs in Canada for a long time. Today Edmonton is the outfitting center, and Winnipeg is Canada's great fur market.

For the same reason that furs are most useful to man in cold regions, we find the chief fur-bearing animals in the arctic or sub-arctic zones. So rapidly have these animals diminished in numbers in our country that Canada and Russia are the chief producers of furs. Our chief centers, as far as a domestic supply is concerned, are St. Louis and St. Paul, but New York is the great center for imported furs. Leipzig, Germany, leads the world as a fur market.

The most important fur-bearing animals are: the otter, beaver, sable, mink, fox, fisher, marten, seal, muskrat, raccoon, bear, skunk and rabbit. Formerly beavers were very numerous in this country, but they are now scarce. Their fur was extensively used in the manufacture of hats. In 1638 the English Parliament, in order to stimulate trade in this commodity, passed a law making it illegal to manufacture hats from any other fur than that of the beaver.

FIG 132.—Fur seals.

Alaska is the chief source of the fur seal. Its summer home is on the Pribilof Islands. The killing of the animals is under government supervision. In the fall the seals migrate southward. From San Francisco the pelts are shipped to London, which is the chief center for the manufacture of sealskin garments.

In the United States and Canada there are farms where certain of the fur-bearing animals are raised. This applies particularly to the black and silver-gray foxes. A single pelt of one of these animals sometimes sells for as much as $1,500.00. Along the shore of Maryland muskrat farming is carried on, and the mink and skunk are raised in various localities. From Australia great numbers of rabbit-skins are shipped to Europe.

STUDIES

What advantage has wool as a fiber? Why are there more sheep than cattle in Australia? What animals furnish skins for the leather industry? Why is the price of shoes so much higher than it was a few years ago? Is the raw silk industry likely to become important in the United States? Explain. Why do most of the furs come from cold countries?

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CHAPTER XXVII

Draft Animals

Horses are more largely employed in carrying on farm work than in any other line. Although on very large farms engines are to some extent employed in plowing the ground, and in semi-arid regions in harvesting wheat, agriculture and horses are inseparably connected. Horses are of great value also in transportation. The products of the farm, the forest, the quarry and the mine are in most cases transported by horses or other animals from the place of production to the nearest railroad or water route. Great numbers of horses are used in moving commodities in cities, although the auto-truck, because of larger load and greater speed, is rapidly taking the place of the horse for this work. Many horses are yet used for riding and driving, and also in war.

Russia raises more horses than does any other country. There is a large home demand, because the population is almost entirely agricultural. Moreover, there is a comparatively small mileage of railroad, inland waterways are not extensively used, and a considerable number of horses are used in the army. The United States and Argentina rank next in the number of horses raised.

Mules are not nearly so numerous as are horses. As mules are possessed of great strength and endurance, they are used for heavy work. The United States ranks first, and Spain second, in the number of mules raised. In Italy, South America and Mexico large numbers of mules are employed because mules can be more successfully worked in warm climates than can horses.

Asses are largely used as pack animals, although to some extent they serve as saddle beasts. Being sure-footed, they are used in mountainous districts where roads have not been constructed. The animals are cheap, and during the summer practically provide themselves with food. Asiatic Turkey, India, Spain, Italy, France, South America and Mexico use many of these animals.

Cattle were formerly used in large numbers. They are patient and strong, but are too slow to be used in transportation, and in most parts of the world they are most valuable in furnishing a food supply. In South America, Mexico, our Southern States, and to some extent in the Old World, cattle are employed.

The **water buffalo**, or carabao, is used in tilling the soil, and in a small way for transportation purposes, in India, Egypt, Siam, the Philippines and other hot, moist areas in the Orient. The animal will not thrive unless it can immerse itself in a pool of water several times daily.

The **elephant** is a very useful animal in India, Ceylon, Burma and Siam. Elephants are used for transportation, and in Siam in particular they are employed in piling logs and timber.

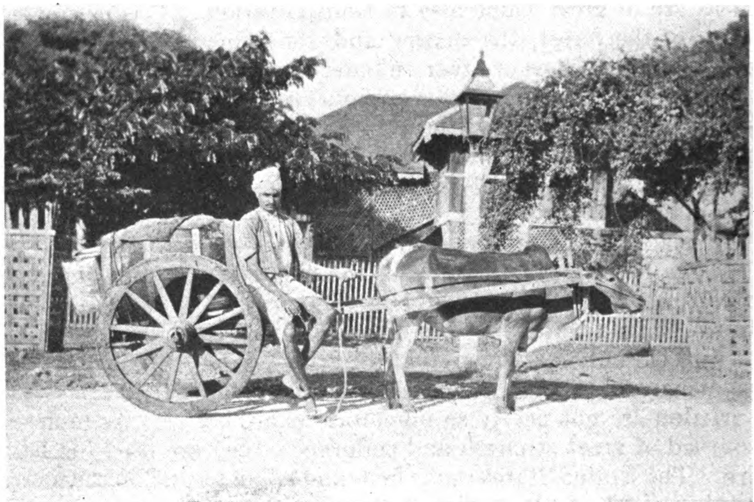

Photo by E. A. Magie.

FIG. 133.—Transportation in Mandalay.

The **reindeer** is as valuable in the arctic regions as is the camel in the hot deserts. The animal is swift of foot, requires comparatively little attention, and is quite strong. In Norway, Sweden, Finland, Siberia and Alaska they are used for transportation purposes, and quite recently they have been introduced into Newfoundland. The flesh of the reindeer is eaten, its milk is used and its skin is converted into clothing and tents.

Camels are all-important to man upon the hot deserts. This is because they can go without water for several days, can eat the thorny vegetation which grows upon deserts, and can carry large loads.

The dates grown upon the Saharan oases reach the Mediterranean ports of Africa upon the backs of camels, and Egyptian cotton is carried to the Nile by the same means. Tea and silk from China find their way by camel-caravan into Russia, and the only way of crossing the wastes of Arabia is on camel-back. In Egypt camels are used in plowing. Camels are now being used in transporting materials to and from the arid regions in western Australia.

The **llama** is related to the camel, although it is much smaller. It is of great value to the people who inhabit the lofty Andean plateaus. Before railroads penetrated these areas the llama furnished the only means of transporting the products of the mines

FIG. 134.—Transportation by reindeer.

and in carrying the supplies to the plateau cities from the outside world. Llamas are used successfully at altitudes to which neither the horse nor the mule is adapted. They are sure-footed and require little food, but the load carried is small—seldom more than 100 pounds.

Dogs are found wherever man lives, but in few regions do they serve any other purpose than that of companions of men or guardians of their property. In Alaska, Greenland, Holland and Belgium dogs are employed as draft animals. In Alaska and Greenland it is impossible to use horses in making long winter trips because sufficient food for the animals could not be carried. It is not so difficult to carry food for dogs, and because of the nature of the food, some can usually be provided while on the trip. Dogs have played a very important part in polar expeditions. In Holland and Belgium dogs are used in delivering milk and vegetables. During the World War much service was rendered by dogs.

STUDIES

Is the number of horses in the United States increasing or diminishing? Explain. Why are mules less numerous than horses in our country? Why are there so few horses in China? Why does the camel take the place of the horse in certain desert areas? Why is the dog more useful than the horse on polar expeditions? Why is the llama so valuable in the high Andes? Is the elephant in danger of extermination?

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PART FIVE

MINERALS IN THEIR RELATION TO MAN

CHAPTER XXVIII

Minerals as Fuels

General Statement.—In countless important ways minerals influence the present-day life of men. Coal, oil and gas have largely displaced wood as a fuel. The large buildings in our cities are generally constructed of brick, concrete, stone and steel. Whether we travel by carriage, auto, trolley, train or steamship, the vehicle in which we ride is made in part of iron and steel. The tools with which the farmer, miner and mechanic carry on their daily work are made of the same materials. The money used in all parts of the world is in large part made of metal. Our writing is carried on by means of metal pens or machines, and overland and under-sea messages are flashed along wires.

It is primarily her vast deposits of coal and iron that give Great Britian her important position in the affairs of the world. Germany and the United States owe their industrial greatness in large part to their enormous mineral wealth. The so-called precious metals have led to large movements of population, to the construction of roads and the rapid building of towns. California, South Africa, Alaska and western Australia are notable examples of areas the development of which has been strikingly influenced by deposits of gold.

Minerals are known as metallic and non-metallic. Among the metals are: iron, copper, lead, zinc, tin, mercury, gold and silver. The non-metallic minerals are very numerous. Coal, petroleum, building stones, clay, salt and sulphur are illustrations, and are widely distributed.

COAL

General Statement.—Coal is one of the most valuable of natural resources. Owing to its great value as a fuel, it is extensively used in the heating of buildings. The trains which convey freight and passengers in all parts of the world are for the most part drawn by coal-burning engines. Coal is used upon the steamships that navigate rivers, lakes and oceans. In every city the smokestacks of manufacturing plants pour out their coal smoke. In countless ways coal is related to the daily lives of most people. The nations which are the most important in the production of coal are also the most important industrially.

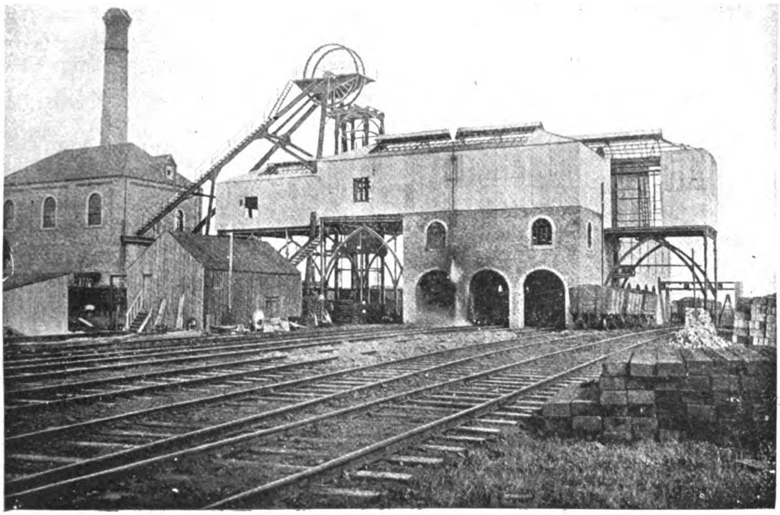
By partially burning coal, coke is produced. Coke is harder than coal, and makes a hotter fire. On this account it is largely used in the smelting of iron. The gases which are given off in the production of coke are utilized in the manufacture of coal-tar, dyes and various drugs and chemicals.

Origin.—That coal is of vegetable origin can be shown in several ways. (1) The woody tissue may be traced in the coal, either by the unaided eye or by means of the microscope. (2) Stumps of trees, several feet in length and converted into coal, have been found upright in the coal measures with roots in the underlying foundation. (3) In the peat bogs of today we see coal in the first stages of its formation. (4) Analysis of coal shows its vegetable origin.

While the Carboniferous was the great coal-forming period, workable coal seams are found in the rocks of practically all ages. Coal is found in layers called *seams*. These vary in thickness from a few inches to many feet. The seams are separated from one another by layers of sedimentary rock, generally shale or sandstone, although limestone is sometimes found. From this we see that each coal seam must represent a time when the area was land, for on this basis only can the vegetation be accounted for. Each layer of sedimentary rock shows that the area was submerged, for in no other way can the existence of the rock be explained. In other words, there were many oscillations of the land during the coal-forming period.

Was the vegetation of which the coal is formed drifted into basins, or did it grow in the situations where the coal is now found? If streams during floods carried trees into lakes or other depressions, and there left them, they would have been piled up and consequently our coal deposits would not be so uniform in thickness as they are. Furthermore, these same torrential streams would have carried great quantities of sand and gravel, and hence the coal would be much more impure than it now is. It seems evident that the vegetation grew where the coal fields now exist, and the streams were, for the most part, slow-flowing, and hence carried fine sediment. In spite of this, some authorities believe that coal, in many cases at least, was formed from materials drifted to the locality. During the submergence of the vegetation the salts such as potash were dissolved. It is because of this that coal ashes are of no value as a fertilizer.

Because of the pressure and the heat resulting from the accumulation of sediments, the vegetable matter was greatly compressed and otherwise changed. A given thickness of coal represents about 7 per cent. of the original thickness of the layer of vegetation which entered into the formation. Thus one foot of coal represents an accumulation of vegetable matter about fourteen feet in thickness This signifies a long period of time.



Courtesy Engineering Magazine.

FIG. 135.—A modern colliery.

During the process of coal formation hydrogen, oxygen and nitrogen are given off, with the result that at each successive stage in the process the *relative* amount of carbon is increased. The following table will make this clear. The figures used represent average conditions.

TABLE 31.

	Carbon per cent.	Hydrogen per cent.	Oxygen per cent.	Nitrogen per cent.
Wood	50	6	43	1
Peat	59	6	33	2
Lignite	69	5.5	25	0.8
Bituminous	82	5.0	1.3	0.8
Anthracite	95	2.5	2.5	Trace

Distribution.—Although coal is quite widely distributed, three countries—the United States, Great Britain and Germany—produce the bulk of the world's supply. Austria-Hungary, France, Russia, Belgium, Japan, China, India, Canada and Australia each produce considerable quantities.

In the United States there are six coal fields: the Eastern, the Gulf, the Interior, the Great Plains, the Rocky Mountains and the Pacific. The first named produces about 75 per cent. of our coal and the interior field ranks second in importance.

Production.—

TABLE 32.

AVERAGE OUTPUT OF LEADING COAL-PRODUCING COUNTRIES FOR THE FIVE-YEAR PERIOD ENDING WITH 1913. SHORT TONS. ROUND NUMBERS.[1]

Country	Tons
United States	512,600,000
Great Britain	300,000,000
Germany	265,000,000
Austria-Hungary	50,000,000
France	38,500,000
Russia and Finland	28,000,000
Belgium	24,500,000
World	1,325,000,000

In 1868 the United States ranked third as a coal-producing nation, having but 15 per cent. of the world's supply to her credit. In 1872 she took second rank and in 1899 first. The value of our total output in 1919 was, at the mines, about $1,500,000,000, and in amount it was about 40 per cent. of the world's output.

TABLE 33.

AVERAGE ANNUAL PRODUCTION OF COAL IN THE UNITED STATES. FIVE-YEAR PERIODS. SHORT TONS. ROUND NUMBERS.[2]

Years	Tons
1880-1884	99,000,000
1885-1889	128,000,000
1890-1894	132,000,000
1895-1899	211,000,000
1900-1904	314,000,000
1905-1909	432,000,000
1910-1914	542,000,000
1919- (estimated)	600,000,000

[1] "Mineral Resources of the United States."

[2] Compiled from "Mineral Resources of the United States."

In the order of their importance the chief coal-producing states ranked in 1915 as follows: Pennsylvania, West Virginia, Illinois, Ohio, Kentucky, Alabama, Indiana and Colorado. Practically all of our anthracite coal comes from Pennsylvania, although New Mexico and Colorado produce small amounts. Modern methods of heating buildings have reduced the demand for anthracite coal in one direction.

Mining.—Much of the work of handling coal in the United States is done by machinery, while in Europe hand labor is more largely employed.

Drills operated by compressed air make holes in the roofs and sides of the chambers. Cartridges exploded in these holes shake down great quantities of both coal and rock. Helpers place the coal on small cars. These may be hauled out by mules or electric motors, or carried up the shaft by an elevator.

Under favorable conditions, horizontal tunnels or *drifts* can be run from the surface of the earth to the coal. This lessens the cost of production. When the coal lies far below the surface, shafts are sunk vertically to it, and drifts are run in various directions from the foot of the shaft.

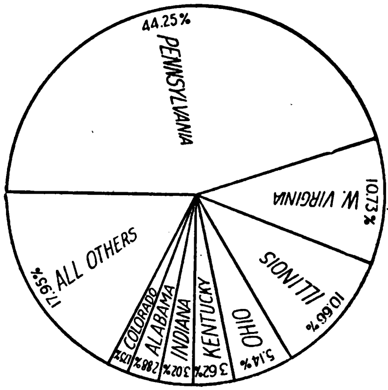


FIG. 136.—Production of coal in the United States. Percentages by states. 1914-1918 inclusive.

A miner is generally paid by the ton. The *helpers* are employed and paid by the miners. There were in our country, in 1915, 734,008 persons employed in mining and handling coal. They averaged about 238 working days in the year. In the anthracite mines the miners averaged about 2.10 tons daily, and in the bituminous mines about 3.61 tons.

The Coal Trade.—Our coal is shipped both by rail and water. The railroads have a controlling interest in the coal mines, and the amount of coal that each road is to transport during the year is agreed upon beforehand. Many coal barges are floated down the Delaware, the Philadelphia market receiving a part of its supply in this way. Pittsburgh, our greatest coal market, receives about 25 per cent. of her coal by water. Boston and New England markets generally get most of their coal by water. Coal vessels are unloaded by machinery at a cost varying from eight mills to two cents per ton.

Our leading coal centers are Pittsburgh, Philadelphia, Chicago, Toledo, St. Louis, Boston, Cleveland, Cincinnati and Milwaukee. The water rates on coal from Buffalo to Duluth and Superior are about 50 cents per ton.

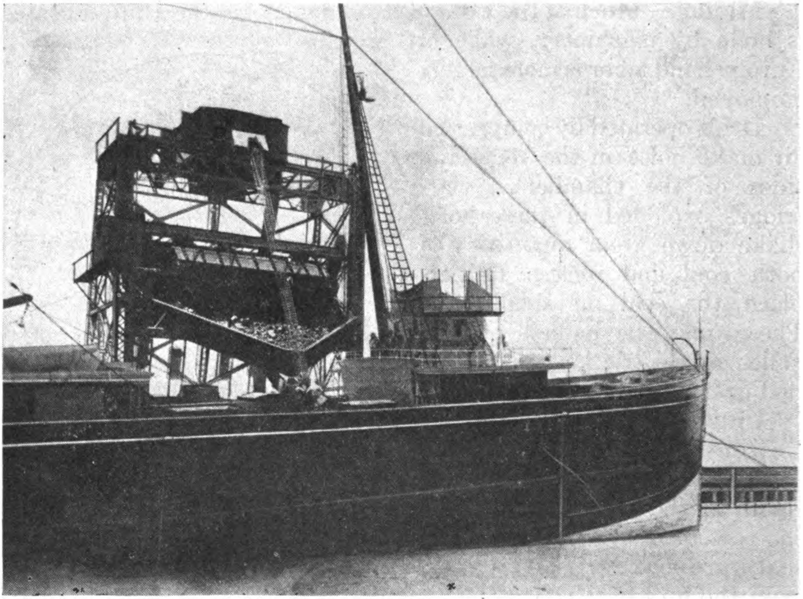


FIG. 137.—Transportation of coal by lake vessel. Note the dock machinery picks up the entire car of coal and turns the coal into the vessel's hold.

We consume 96 per cent. of our production of coal, and hence export a comparatively small amount. New York, Philadelphia and Mobile are our chief exporting centers. A smaller quantity is imported. Australia, New Zealand and British Columbia ship coal to California, and Nova Scotia furnishes New England a part of her supply.

England is the world's greatest exporter of coal. No other raw material holds a larger place in the exports of the country. Both Italy and Switzerland are practically without coal and hence import considerable quantities. France imports English coal.

Cost.—The cost of coal to the consumer depends upon the cost of production and transportation, the number of hands which the commodity passes through and the relation between supply and demand. As a rule the mines in this country are not as deep as they are in European countries, hence our cost of production is lower. On the other hand, the haul is longer in this country than it is in some parts of Europe, varying from 100 to 200 miles. In England it does not average more than 50 miles.

Peat, which is coal in the first stages of its formation, is quite widely distributed. It is dark in color, somewhat spongy in texture and clearly shows its vegetable origin. Ireland, which is poor in coal, is rich in peat, and great quantities are cut from the bogs, dried and burned. The same is true in Holland and Belgium. In Canada there are great areas of peat bogs. In our country, Wisconsin, Minnesota, Michigan, New Jersey, Florida and other states are rich in peat. In some states peat lands, when drained, produce excellent celery.

When peat has undergone further change, due to heat and pressure and the relative amount of carbon has increased considerably, it is called lignite. Coal of this character has, until recently, been considered practically worthless. The next step in the process gives us bituminous coal. This variety of coal is much more widespread than is anthracite or hard coal.

History.—In his book on "Stones," written about 315 B. C., the Greek philosopher Theophrastus mentions a substance that would kindle and that could be used by smiths. This was no doubt coal. In 1239 Henry III of England granted a charter for operations in the Newcastle field. The existence of coal in the United States was first reported by Hennepin in 1679, who observed it on the Illinois River near where the town of Ottawa, Illinois, now stands. It was first mined in Virginia about 1749, near Richmond.

Waste.—The World War increased the demand for coal and drew our attention to the *waste* as well as to the extensive use of this fuel. Our coal deposits can not be replaced, hence we should use our supply thoughtfully. Millions of tons of coal are wasted in our country yearly because of improper firing. Much coal drops from the cars during transportation. Coal is wasted in making electric energy used in unnecessary display of electric signs in every large city. Coal may be saved by not allowing the winter temperature in our houses to rise above 68° F.

Future Supply.—Much has been said and written regarding the future of the coal supply. That it will in time be exhausted is certain, but that the time is far distant is equally certain. The increased use of petroleum and water power are in some sections decreasing the use of coal. China has great deposits of coal, which are for the most part untouched.

Investigations carried on at the St. Louis Exposition have shown that lignite, when made into producer-gas and burned in a gas engine, has from two to three times as much value as a power producer as has coal. Ordinary coal in a steam plant yields less than 5 per cent. of its energy in the production of power. A producer-gas plant will yield 20 per cent. When it is understood that in Montana, North Dakota, New Mexico, Texas, and other Western States there are vast deposits of lignite, the tremendous importance of the investigations referred to begin to be realized.

The life of our coal supplies will be still further extended through the briquetting of the coal dust, sometimes called *culm*. Immense amounts of this material are now wasted. In Europe great quantities of briquettes are manufactured, and there are now a number of plants in operation in our own country.

One of the very interesting facts regarding the coal industry in the United States is that for a long time the output has practically doubled with each decade. In 1850 our per capita consumption of coal was a trifle more than one-fourth of a ton per year. In 1920 this was increased to about 6 tons. This is an index of our development as a manufacturing nation.

The Coal Land Act, passed during Mr. Roosevelt's administration, represents a tremendously important step in the conservation of our fuel resources. By virtue of this act land was set aside from entry pending its classification and valuation. This work was performed by the Geological Survey. The land is valued according to distance from a railroad, amount and quality of coal. The minimum is $10.00 per acre, and in some cases a valuation in excess of $400.00 per acre has been fixed. The money derived from the sale of the coal lands goes into the Reclamation Fund.

PETROLEUM

History.—The use of petroleum is almost as old as civilization. The Babylonians soaked their bricks in oil and wrapped the bodies of their dead in cloths saturated with it. The sacred fires which centuries ago were kept burning along the shores of the Caspian Sea were probably seepages of oil which had been ignited. Petroleum has been known in our country for a long time. In early days people frequently collected it from the surface of streams or ponds and used it as a medicine. In 1852 some petroleum was distilled and burned in a lamp, and in 1859 the first oil well was sunk in Pennsylvania.

Origin.—Because petroleum is found in rock, it is often called *rock-oil*. In fact the word petroleum means rock-oil, being derived from the Latin *petra*, rock, and *oleum*, oil. The necessary geological

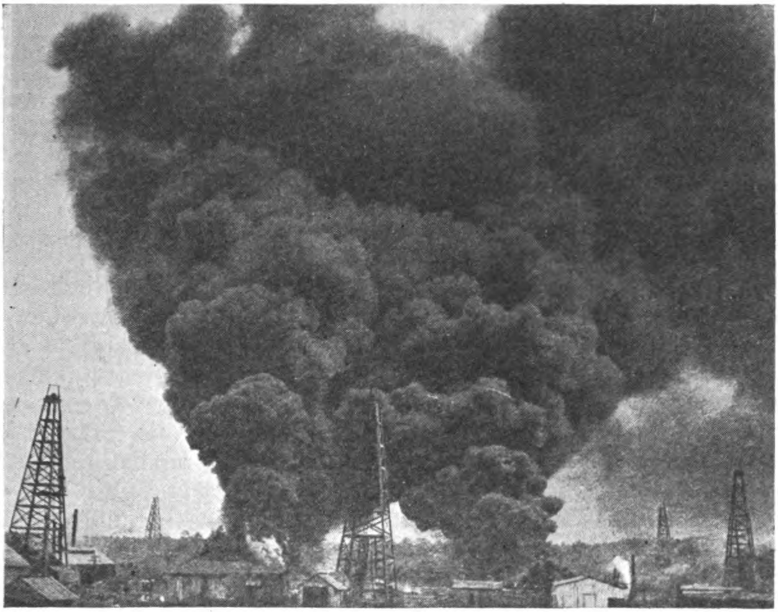


Photo by Chamberlain.

FIG. 138.—Petroleum well on fire.

conditions are: (1) A porous stratum to hold the oil; this is sandstone or shale. (2) Impervious layers above and below to prevent the escape of the oil.

When the bodies of plants and animals decay, hydrogen and carbon are given off. If the bodies decay on the surface of the earth the gases, of course, pass into the atmosphere. Where this change takes place under the beds of sand or mud, hydrocarbons, as they are called, are saved—stored up for the use of man. Gas, oil and salt are often found in association. The gas is at the top, and the salt at the bottom.

Distribution and Production.—The leading petroleum-producing countries of the world are the United States, Russia, Mexico, Rumania, the Dutch East Indies and India. The world's output in 1915 was, in round numbers, 427,500,000 barrels, of which the United States produced more than 281,000,000 barrels, or 65 per cent. of the total. Mexico's output has increased from 1,000,000 barrels in 1907 to 33,000,000 barrels in 1915.

TABLE 34.

RANK OF PETROLEUM-PRODUCING STATES, BASED ON QUANTITY OF OIL MARKETED, 1914 AND 1915 [3]

State	Rank	Barrels	Per cent.	State	Rank	Barrels	Per cent.
California	1	100,000,000	37	Oklahoma	1	98,000,000	35
Oklahoma	2	74,000,000	28	California	2	87,000,000	31
Illinois	3	22,000,000	8	Texas	3	25,000,000	9
Texas	4	20,000,000	7	Illinois	4	19,000,000	7
Louisiana	5	14,000,000	5	Louisiana	5	18,000,000	6

During recent years the Western fields have increased their output enormously, but the Eastern fields have decreased in importance. In 1915 California and Oklahoma each produced one-third of the total output of the United States, and more than was produced by Russia. The average price per barrel in 1915 ranged from about 40 cents in California to about $1.58 in Pennsylvania. The most productive area is Kern County, California. This produced in 1915 more than one-half of the total.

Until recently it was thought that California oil could not be profitably refined owing to the fact that it is a low-grade oil. There are now a large number of refineries, however, and most of the kerosene used in the state is manufactured near San Francisco.

The average depth of the wells in the Kern River district is about 1,000 feet, and the cost of an equipped well averages in the neighborhood of $5,000.00. It is estimated that the oil-bearing sands are about 20 per cent. petroleum, and as the sand is in places several hundred feet in thickness, there is an immense amount of oil in the state.

Uses.—From petroleum, asphaltum, distillate, lubricants, kerosene, gasoline, vaseline, paraffin, benzine and other things are produced. Railroads operating in the western part of our country use oil as a fuel for locomotives almost exclusively. Less extensively it is used for the same purpose in all sections of the United States. In

[3] U. S. Geological Survey. Petroleum in 1915, p. 567.

addition to being less expensive than coal, it is cleaner, and is less liable to cause forest fires than is coal. Some of the ships in our navy burn oil and others are being equipped to use it.

Operation.—When a well is sunk into an oil-bearing stratum the oil can be pumped out. Sometimes, owing to pressure, the oil flows or gushes out. In the early days of the oil industry in Pennsylvania much oil was lost. It gushed from the wells and flowed down the streams. Russell Hastings Millward states that an oil well near Tampico, Mexico, burned continuously from July 4, 1908, until August 30, 1908, causing a loss estimated at $3,000,000.

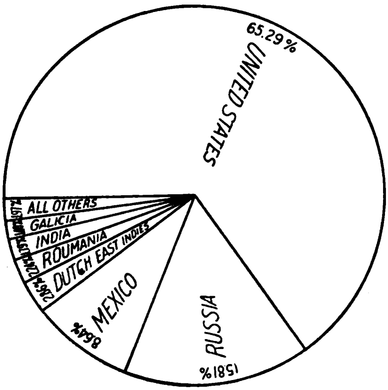


FIG. 139

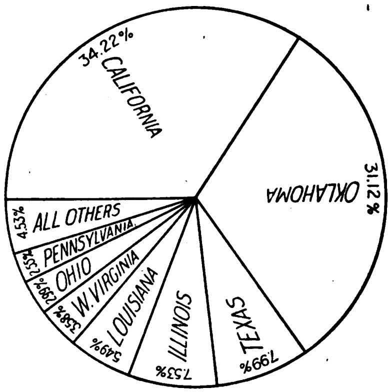


FIG. 140

FIG. 139.—World's production of petroleum, 1916. Percentages by countries.
FIG. 140.—Production of petroleum in the United States. 1912-1916 inclusive.

By means of a *derrick*, an iron pipe, inside of which there is a drill, is driven into the rock. The pipe may be nearly a foot in diameter at the surface of the well, but not more than two inches at the bottom.

From the oil fields the petroleum is carried to the refineries on cars, ships or in pipe lines. A pipe line extends from Olean to New York City, a distance of 300 miles. One of the long pipe lines of the world extends from Bakersfield, California, to San Francisco, a distance of 278 miles. In our country the great refineries are in New York, Philadelphia, Buffalo, Cleveland and Chicago. We export much oil in tank ships.

Baku is the center of the oil industry in the Caspian Sea district. The oil is used as a fuel on steamers plying upon the Volga and the Caspian Sea. It is also used on the railroads in that part of Russia.

A large amount is piped to Batum on the Black Sea. The line connecting Batum with the Baku oil fields is about 450 miles in length.

In the black shale rocks of our country we have a vast oil resource with which we are now experimenting. The heating of these shales yields an oil, which if not identical with petroleum, is an excellent substitute.

The oil shales are very extensive in Utah, Colorado, Wyoming and other Western States, and in the central part of our country there are very rich shale formations. It has been estimated that we have in these rocks a quantity of oil several times as great as our original petroleum resource.

For several years Scotland, France and New South Wales have been exploiting their oil shales. During the World War Great Britain made extensive use of the oil obtained from the shales of Scotland.

Among the many valuable products of petroleum is gasoline. As petroleum is heated a vapor is given off which, upon condensation, becomes gasoline, one of the important fuels of today. We depend upon this fuel in the operation of our automobiles, auto-trucks, airships and tractors.

Every user of an automobile can help to conserve this precious fuel. If by careful driving we could save one pint of gasoline per auto per week, the total saving would amount to about 25,000,000 gallons yearly.

NATURAL GAS

Natural gas is the result of the distillation of plant and animal life, and therefore is found associated with petroleum. Like petroleum, the supply of natural gas, of course, is temporary. In the early days of the petroleum industry little attention was paid to natural gas, and as it is often under enormous pressure, great quantities have been allowed to go to waste. This was especially true in Indiana.

Although natural gas is our most perfect fuel, it was not used extensively in manufacturing until recent years. Today it is largely employed in the glass and in the iron and steel industries, as well as for the purpose of illumination.

The United States is the chief producer of the natural gas. The average annual value of our output for the five years ending with 1915 was about $88,000,000. During this period there was a steady increase amounting to some 30 per cent. Russia, Italy, Canada, the United Kingdom and Hungary produce some natural gas.

TABLE 35.

VALUE OF NATURAL GAS PRODUCED IN THE UNITED STATES IN 1915[4]

State	Value
West Virginia	$36,000,000
Pennsylvania	$21,000,000
Ohio	$17,000,000
Oklahoma	$ 9,000,000
California	$ 4,000,000
Kansas	$ 4,000,000
New York	$ 2,000,000

STUDIES

Make a list of all of the materials used as fuel. What is the chief fuel in your locality? Where does the coal used in your vicinity come from? Trace the route or routes of shipment. Account for the presence or the absence of coal deposits in your state. How long is the coal supply of the world likely to last? Should our government control the coal industry? Why is California especially fortunate in having a large supply of petroleum? Why has there been such a great increase in the production of petroleum in our country during recent years? Write a paper telling of such waste of mineral fuel as you have actually observed, and how such waste may be prevented?

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[4] "Mineral Resources of the United States," 1915. Part II, p. 933.

CHAPTER XXIX

Building Stones and Clay Products

STONE

General Statement.—For thousands of years stone has been used in the construction of buildings, and its use for this purpose is more general today than ever before. In some countries stone is especially valuable because of a lack of timber. From the standpoint of permanency, stone has a great advantage over wood as a building material. Being fireproof, the rates for insurance on stone buildings are low, as only the furnishings can be destroyed by fire. Some kinds of stone take a polish which adds to the beauty of buildings constructed of them.

The kinds of stone most important commercially are limestone, granite, traprock, marble, sandstone and slate. As the kinds of stone mentioned are widely distributed, and as their transportation by land is expensive, quarries are seldom operated far from the markets to be supplied unless they are situated close to navigable waters.

Granite.—The value of the granite quarried in the United States in 1915 was about 24 per cent. of the value of our total output of stone for that year. Vermont, Massachusetts, California, Wisconsin, North Carolina and New Hampshire were the leading producers in that year. For the five years ending with 1915, the average annual value of the stone output of the United States was a little more than $78,000,000.

Granite is an igneous rock which always contains feldspar and quartz and very commonly mica. It is resistant to weathering and takes a high polish, and is therefore very valuable as a building stone. The Congressional Library in Washington, D. C., and the Temple in Salt Lake City are examples of buildings made of granite. In addition to its use as a building stone, granite is extensively employed in the construction of monuments, curbs and paving blocks, and is used as a ballast on roads, streets and railroads.

Traprock is a basaltic rock, the chief uses of which are in the construction of roads and concrete, although it is also used for building purposes. The states most important in the production of this rock are California, New Jersey, New York, Pennsylvania, Massachusetts and Connecticut.

Sandstone. a sedimentary rock, is widely distributed. It is inorganic in origin, being constructed from sand grains deposited in the water and chiefly produced by stream and wave erosion. The sand grains are bound together by a cementing substance. When this cementing substance is silica, the sandstone is durable. As the grains of sand are relatively heavy, sandstone is formed rather close to shore. Areas of sandstone furnish evidence of a change in position of land and water. New York, Pennsylvania and Ohio are important

Photo by Chamberlain.

FIG. 141.—Quarrying limestone.

producers of sandstone. Besides being used for building purposes, sandstone is of considerable value in the manufacture of grindstones and whetstones. At Berea, Ohio, grindstones are made in large numbers because sandstone of the proper kind is available.

Limestone.—Our limestone output is more valuable than our granite. Pennsylvania, Ohio, Indiana, Illinois, New York and Missouri are the chief producers. Like sandstone, limestone is a sedimentary rock, but it is of organic origin. From the ocean waters animals obtain lime which they build into their skeletons. When the animals die the lime in their skeletons is converted into limestone rock.

The large limestone area in the Mississippi valley shows that this part of our country was once covered by the sea. Limestone frequently contains fossils which throw much light upon the geological history of the earth.

Limestone is used in the construction of buildings, as flags for sidewalks, in paving streets, in the manufacture of lime and as a furnace flux. When limestone is heated to a high temperature out of contact with the air, the carbon dioxide (CO_2) is expelled and calcium oxide or common lime (CaO) is left. The presence of limestone close to deposits of coal and iron is very important. In smelting iron, layers of limestone are added because, when the rock fuses, the lime reacts with sand and silicates, forming a flux which floats, and in this way impurities are removed.

Marble.—When limestone has become sufficiently changed (metamorphosed) by heat and pressure, it becomes a metamorphic rock known as marble. Marble takes a high polish and is therefore much used by sculptors and in the making of pillars and other ornamental parts of buildings. It is much more easily damaged in quarrying than is limestone or granite and blasting is seldom resorted to.

Italy has long been noted for her beautiful marble produced at Carrara. Although worked for 2,000 years there are large amounts remaining in these deposits. Europe draws her supplies of the finest marble from the Italian quarries and the United States imports some.

The Carrara quarries support about 75,000 people. As the rock is blasted, there is much waste. The expense of production is greatly lessened by the fact that the marble comes from a mountain side and gravity aids in getting it to the railroad which connects the quarries with Avenza, three miles distant. The marble to be exported goes to the ports of Leghorn and Genoa.

In the United States, Vermont, Georgia, Colorado, Tennessee, New York, Alabama, Massachusetts, Pennsylvania and California are the chief marble-producing states.

Slate.—Shale is composed of mud particles hardened and cemented and is another sedimentary rock. Slate is altered (metamorphosed) shale. Having the property of cleavage highly developed, slate is very useful as a roofing material. In addition to this, it is used in making blackboards, school-slates, flooring, wainscoting, vats, laundry-tubs, refrigerator shelves, mantels and table-tops.

In the United States the chief use to which slate is put is in the roofing of houses. Pennsylvania and Vermont are our most important producers. We export some slate to European countries.

CLAY PRODUCTS

Traveling on a wet road or unpaved street is very disagreeable if clay be a plentiful ingredient of the soil. The adhesive quality of clay is so great that considerable quantities of it are lifted, when wet, by the feet of pedestrians and horses, and larger masses cling to the wheels of vehicles. When clay dries it hardens.

Brick.—Thousands of years ago people learned to take advantage of the fact that clay can be moulded when wet and that it hardens

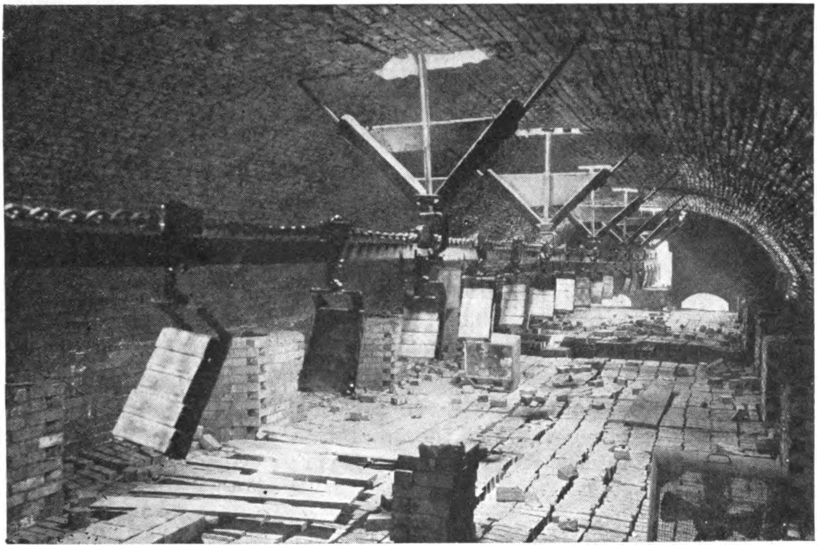

FIG. 142.—A brick-conveying machine.

when it dries. Crude bricks were fashioned and dried in the sunshine. These were then used in the construction of houses. This was a matter of great importance in the valleys of the Tigris and the Euphrates, in the Holy Land and in Egypt, for in these places there was practically no timber. The early Spanish settlers in California built their houses of sun-dried bricks. Such buildings were called *adobe* houses. They were also used in Utah to some extent, and in the drier parts of Mexico there are many today.

Clay is the result of the decomposition of several minerals, particularly feldspar. It is widely distributed, hence the clay industries are important in many countries. Clay is used in the manufacture of building-brick, fire-brick, paving-brick, pottery, drain-tiles, tiles for roofing, sewer-pipe, and to some extent it enters into the manufacture of paper.

As related to manufacturing, clay owes its importance chiefly to the use of bricks as a building material. On account of the greater protection against fire afforded by the use of artificial stone and tile, as well as the fact that hollow blocks permit greater uniformity of temperature and do not conduct sound readily, these materials are to some extent displacing brick.

At the close of the glacial period, great quantities of clay were left in a lake occupying what is now the lower Hudson valley. The presence of the clay on the one hand, and the growth of cities on the other, have made the region the chief brick manufacturing center in the United States. Brick works are scattered along both sides of the Hudson from New York City to Cohoes. The Hudson affords cheap transportation, and this has its effect upon the price of brick in New York, which was, in 1915, only about $5.00 per thousand. The average price for the United States during the same year was $6.15, and for Wyoming $10.23. In 1920 prices were much higher.

Illinois ranks high as a brick producer. The industry is largely localized in Cook County, the county in which Chicago is situated. About two-thirds of the output of the state comes from this one county, which rivals the Hudson district in importance. Pennsylvania, New Jersey and Iowa are important in the manufacture of bricks. The average value of the annual output of common bricks in the United States for the five-year period ending with 1915 was about $47,000,000.

Table 36 shows in a striking manner the influence of clay deposits upon the building material used in certain cities.

TABLE 36.

NUMBER OF PERMITS FOR NEW BUILDINGS IN 1915.[1]

City	Wooden Buildings	Brick Buildings
Boston	1219	445
Chicago (1911)	2240	6583
Milwaukee	1729	329
Minneapolis	3738	254
St. Paul	1217	198
New York	147	1087
Philadelphia	190	10429
Portland, Oregon	1966	77
Seattle	3473	51

[1] "Mineral Resources of the United States," 1915. Part II, pp. 913-916.

Pottery.—In the manufacture of pottery the purest form of clay, known as *kaolin*, is used. Ohio, New Jersey, West Virginia, New York, Pennsylvania and Indiana are the leading states in the pottery industry. Trenton, New Jersey, and East Liverpool, Ohio, are the chief pottery manufacturing centers in our country. The average value of our annual output of pottery for the five-year period ending with 1915 was about $36,000,000.

Much pottery is made at Limoges, France, because of the deposits of kaolin and clay close at hand. Holland, Belgium and Great Britain are large producers. The United States imports considerable quantities of pottery from these countries.

The average annual value of the clay products manufactured in the United States for the five years ending with 1916 was about $175,000,000. Ohio, Pennsylvania, New Jersey, Illinois and New York are the chief states in the industry.

STUDIES

What building stones are found in your state? What do the presence and the character of these rocks tell you as to the geological history of the area? Is brick extensively used in your vicinity? Explain. Name some parts of the world in which the use of pottery developed early. Explain.

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CHAPTER XXX

The Metallic Minerals

IRON

General Statement.—Iron, although not a "precious metal," is the most valuable of all the metals. In very many important ways iron and steel enter into the daily lives of hundreds of millions of human beings. Articles made of iron and steel are used in almost every industry, and transportation and communication make large demands upon these useful metals.

Smelting and Refining.—Iron is seldom found in a pure state but exists as an ore. Its chief forms are magnetite (Fe_3O_4), hematite (Fe_2O_3) and limonite ($2FeO_33H_3O$).

Iron ore is smelted in blast furnaces into which the ore, together with coke and limestone, is placed. The coke is, of course, the fuel and the limestone is used because the silica and other impurities which the ore contains unite with the lime. The slag thus formed is much lighter than the molten iron and floats upon it. Owing to this arrangement, the iron and slag can be drawn off separately.

The molten iron is run into moulds upon a sanded floor, forming cast iron, or *pig* iron as it is commonly called, or it may be at once converted into steel. Cast iron is brittle and steel is made by removing most of the carbon from the iron. Sulphur and phosphorus are also objectionable in steel making. Hematite, containing least of these substances, is the most valuable in the manufacture of steel.

The manufacture of steel was very expensive until Henry Bessemer about 1860 discovered the Bessemer process. It is interesting to note that the discovery of a cheap method of making steel grew out of an attempt to produce a material which would be better suited to the manufacture of cannon than is cast iron. The esssential point in the Bessemer process is that air is blown into the molten iron. This, of course, means combustion within the iron and this burns out the impurities.

The ancient Egyptians and the Greeks used iron. We find its use mentioned in the Bible. Until about the middle of the sixteenth century charcoal was used in smelting iron ore. In 1558 the English Parliament passed an act forbidding the felling of trees for this purpose except in certain parts of the country. The object was to conserve the timber and bring about the use of coal. During the process of bringing about the change the iron industry suffered greatly.

Distribution.—The United States, Germany, Great Britain, France, Spain, Austria-Hungary, Sweden and Newfoundland are important producers of iron ore. There are large deposits in Brazil and China which are undeveloped.

In order that the manufacture of iron and steel goods may be carried on economically, the iron and coal must be close together

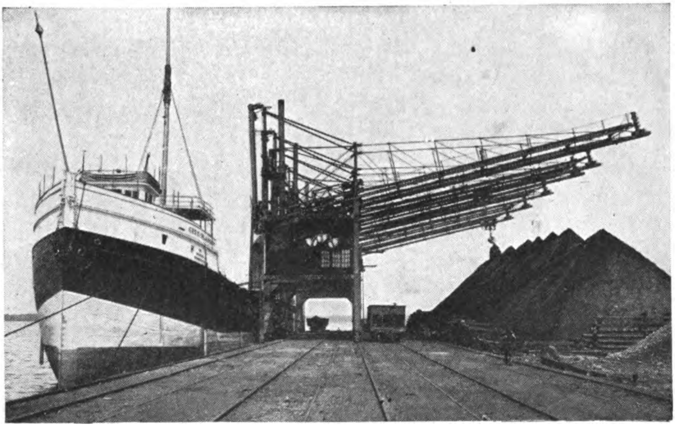

FIG. 143.—Transporting iron ore.

or else there must be water transportation for the ore. The ore is shipped because the amount of coal and limestone used in smelting is greater than the amount of ore.

The United States, Great Britain and Germany are the leading manufacturing countries and each has vast deposits of coal and iron so situated that they may be brought together cheaply. For the making of cutlery Great Britain imports iron ore of high grade from Spain and Sweden.

For the five-year period ending with 1915 our average annual production of iron ore was about 51,500,000 tons. During the years 1916, 1917 and 1918 this output was enormously increased. The chief states are Minnesota, Michigan and Alabama, the first named producing nearly one-half of the total output of the country.

The ore in Minnesota and Michigan is far from coal, but there is cheap transportation to the great iron and steel manufacturing centers by way of the Great Lakes. The iron ore in northern Alabama is situated close to coal and limestone. As a result of this, and also because of the rapid development of the South, the iron and steel industry has assumed much importance in Birmingham and Bessemer.

Growth and Industry.—The concentration of population in cities has so increased the value of land that tall buildings have become a necessity. To secure rigidity, durability and greater protection against fire, much iron and steel are used in their construction. Even

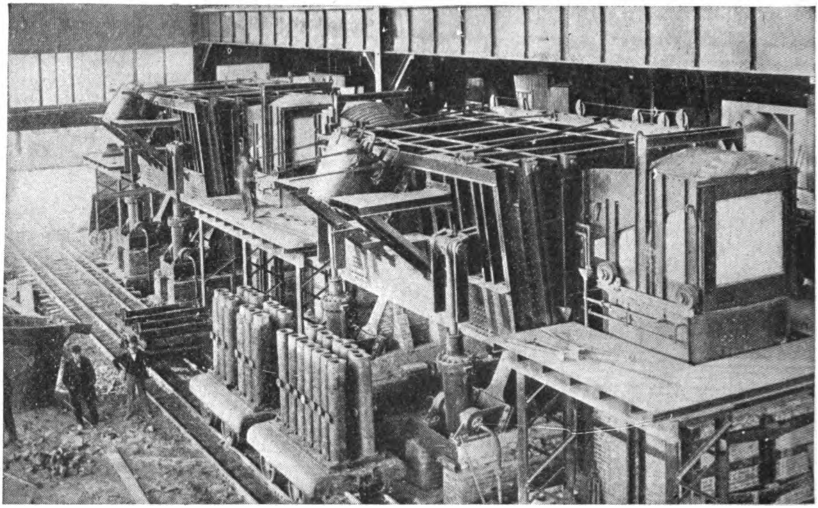

FIG. 144.—Open hearth steel furnace.

in concrete buildings steel rods are used. The astonishing railroad expansion in many parts of the world and the change from wooden to steel ships have stimulated the manufacture of iron and steel. The invention of machinery along all lines to do the work formerly performed by hand has created a large demand for these metals. Preparations for war which are constantly carried on in all important countries call for large quantities of iron and steel and give employment to many men.

Centers of the Industry.—The great English district is in the central part of England, where coal is abundant. Here are located Birmingham, Sheffield and other cities. In Germany the chief district is along the lower Rhine, with coal close at hand. Pennsylvania is the leading state in our country, in part, of course, because it has deposits of iron ore, but chiefly because of its preëminence in coal, the fact that the iron ore from the Superior region can be shipped to Pittsburgh cheaply, and that iron and steel are here near to great markets.

In Pittsburgh and other cities in the immediate vicinity the iron and steel industry is of the first importance. In the Metropolitan District, of which Pittsburgh is the center, the value of the iron and steel goods produced in 1909 was 55.8 per cent. of the value of all of the products of the district and 23.4 per cent. of the value of the total iron and steel output of the United States for the same year.

Steel ships are made at Newcastle, England; Glasgow, Scotland; Stettin, Germany; and Philadelphia in our country. In all of these cases we have the cities located upon navigable rivers, close to coal and within easy reach of iron ore. Locomotives are manufactured at Philadelphia, Trenton, Providence and Schenectady, and cars at Chicago, St. Louis, Philadelphia and Wilmington, Delaware. Steel rails are made in Birmingham, England; Pittsburgh, Pennsylvania; Chicago, Illinois; and Gary, Indiana.

At Birmingham, England, and in the Pittsburgh and Birmingham districts in our country, large quantities of structural steel are produced. Chicago makes farm machinery and tools; Detroit, automobiles; Essen, Germany, cannon; Liège, Belgium, machinery; Troy, New York, stoves; Bridgeport, Connecticut, sewing machines, and Sheffield, England, and Solingen, Germany, cutlery. These are illustrations of the magnitude of the iron and steel industry and of the many uses to which the metals are put.

The World War made a great demand upon our iron resources. Steel ships, cannon, shells, machine guns, rifles, locomotives, automobiles, airplanes were manufactured in great numbers. Our iron was mined more rapidly than ever before and our steel plants were operated night and day. The Delaware River came to be more important than the Clyde as a ship-building center.

Copper.—The United States leads the world in the production of copper, her average annual output amounting to about one-half that of the world's total. In 1850 the United States produced but 1,000,000 pounds of this metal. The rapidly increasing use of electricity has caused an enormous demand for copper used in the manufacture of wire.

For the years 1845 to 1915 inclusive, Montana has produced 31 per cent., Michigan 27 per cent., Arizona 24 per cent., Utah 7 per cent. and California 3 per cent. of our total output of copper. Butte, Montana, and Bisbee, Arizona, are to a large extent dependent upon the copper industry. In 1915 the average price of copper in the United States was about 17½ cents per pound.

TABLE 37.

AVERAGE ANNUAL PRODUCTION OF COPPER FOR THE FOUR-YEAR PERIOD ENDING WITH 1913.[1]

Country	Pounds (round numbers)	Rank
United States	1,162,000,000	1
Mexico	133,333,000	2
Japan	133,000,000	3
Spain and Portugal	119,750,000	4
Australia	98,000,000	5
Chile	78,000,000	6
World	2,330,000,000	

TABLE 38.

AVERAGE ANNUAL PRODUCTION OF COPPER FOR THE FIVE-YEAR PERIOD ENDING WITH 1915.[2]

State	Pounds (round numbers)	Rank
Arizona	376,000,000	1
Montana	274,000,000	2
Michigan	200,000,000	3
Utah	151,000,000	4
Nevada	72,000,000	5
United States	1,220,000,000	

Lead.—The leading lead-producing countries of the world in 1915 were the United States, Spain, Germany, Mexico and Australia. The production of lead in our country from domestic ores has increased from about 18,000 tons in 1870 to 50,000 tons in 1915. During the eight years ending with 1913, the percentage of the world's output contributed by the United States has not fallen below 27 and in 1913 it was 32.

The chief lead-producing states are Missouri, Idaho, Utah and Colorado. In 1915 Missouri produced more than one-third of our total output of lead.

Lead is very commonly found in association with zinc or silver. Much of the commodity is used in the manufacture of white lead, shot, pipes and type metal.

Tin was one of the attractions of the Cornish Peninsula even before the beginning of the Christian era. Comparatively few parts

[1] "Mineral Resources of the United States," Part 1.

[2] "Mineral Resources of the United States, 1915," Part 1, p. 666.

of the world produce tin today. The chief sources of supply are the Straits Settlements, Australia, New Zealand, the United States and Bolivia.

Large quantities of tin are used in the tin plate industry. Tin plating consists in dipping sheets of iron into molten tin. This prevents rusting.

The first tin smelter in the United States was established at Bayonne, New Jersey, after the opening of the World War. We import tin from Bolivia.

Zinc in its crude form is called spelter. The chief sources of production are the United States, Germany, Belgium and Great Britain. In 1912 Missouri produced nearly one-half of our total output. Colorado, Montana, New Jersey, Utah and Kansas produced smaller quantities.

When zinc is combined with copper, brass is produced. Bronze is produced by combining tin and copper. Galvanized iron is iron coated with zinc to prevent rusting. Zinc is also used in the manufacture of paints.

Aluminum, because it is light and does not easily oxidize, is in demand for a variety of uses. To some extent it is employed in lining refrigerators and in the manufacture of mailing tubes and artificial limbs. It is used also in the electrical industry and in the manufacture of automobiles and kitchen utensils.

Platinum is chiefly obtained from Russia, Colombia, the United States and New South Wales. As a very high temperature is required for its fusion and as it is not easily affected by acids, it is used in the manufacture of laboratory utensils. There is a demand for it in photography, dentistry and in the electrical and jewelry business. Its use in the setting of diamonds is increasing. In the United States, California and Oregon are the chief producers.

Quicksilver.—This metal is usually found in the form of sulphide of mercury or cinnabar. The ore is roasted and the resulting vapor is liquefied. It is shipped in flasks holding 75 pounds each.

For hundreds of years Spain has been an important producer. The other countries from which the metal is obtained are the United States, Austria, Italy and Russia. Most of the output of our country comes from California.

Mercury is used to form an amalgam with gold so that the latter can be separated from impurities. Owing to its great density, 13.6, and its ready change in volume with change in temperature, mercury is used in thermometers, barometers and hygrometers. It is used in the manufacture of explosive caps, in combination with tin to coat the backs of mirrors, in medicine and for other purposes.

Silver.—Although silver is widely distributed, the bulk of the world's output is contributed by the United States, Mexico and Canada. Mexico has been a heavy producer of silver since the days of the Spanish conquest, but in the United States little was mined previous to 1860. Much silver is obtained from gold, lead and copper ores.

TABLE 39.

ANNUAL VALUE OF THE SILVER PRODUCED IN THE UNITED STATES. FIVE-YEAR PERIOD ENDING WITH 1917. FIGURES IN ROUND NUMBERS.[3]

Year	Value
1913	$40,800,000
1914	40,000,000
1915	37,000,000
1916	44,000,000
1917	61,000,000
Average annual value	$45,560,000

Nevada, Montana, Idaho, Utah, Colorado and Arizona produce about 75 per cent. of the total.

Silver, being harder and less beautiful than gold, is more generally employed in the arts than is the latter. Large quantities are used in the manufacture of tableware and plate of various kinds. Jewelry and coins which are small in value are made of silver. The price of silver varies in different countries and fluctuates more or less in a given country. The average value in the United States for the years 1910 to 1917, inclusive, was 61 cents per fine ounce.

GOLD

General Statement.—Men endure the cold of the arctic regions, the fevers of the tropical jungle, the pangs of thirst upon the desert, and privations and dangers of many kinds in their search for gold. Countries have been settled, boundaries disputed, railroads built and cities founded because of the discovery of this metal. For many centuries gold has been used and highly prized. Its relative rarity, its beauty and the fact that it is easily worked have caused it to be classed as a *precious metal*. The value of an ounce of gold ($20.67 in the United States) is as great as the average value of several barrels of flour or tons of coal.

[3] Reports of Director of Mint, Treasury Department.

As a result of the disintegration of gold-bearing rocks, fine particles and nuggets of gold occur. As gold is very heavy, these nuggets often are scattered in the pools of streams. It was in this form that James Marshall discovered gold in California in 1848.

Processes.—Gold in the form of flakes and nuggets is called *placer* gold and is obtained by washing the sands and gravels of streams. In the early days pans were used in washing the gravels, but today sluices and dredges are employed. To the bottom of the sluices cross pieces are fastened and on the up-stream sides of these the particles of gold collect.

Hydraulic mining consists in tearing down banks and hills by means of water under pressure. Much of this was done in California in early days and so much material was washed into the streams that it choked the channels, killed the fish, and in some cases spread a layer of sand and gravel over the adjacent land to the detriment of agriculture. Gold is also obtained by dredging in rivers and off shore and by washing desert sands.

There is much gold in the form of veins in quartz rock where it has been deposited by hot, alkaline waters moving toward the surface of the earth. Gold-bearing rock, or *ore*, is mined and crushed by powerful hammers called *stamps*. The fine material is then passed over copper plates coated with mercury. The mercury and the gold combine, forming an *amalgam*, and the rest of the material is washed away.

Distribution.—The distribution of gold in large quantities is not general, but as it is exceedingly valuable in proportion to its mass, transportation is not an expensive operation. A few countries produce the bulk of the world's supply of gold.

TABLE 40.

AVERAGE ANNUAL PRODUCTION OF GOLD, 1911-1915 INCLUSIVE.[4]

Country	Value	Rank
Africa	$205,000,000	1
United States	98,000,000	2
Australia	52,000,000	3
Russia and Finland	27,000,000	4
Mexico	15,000,000	5
Canada	14,000,000	6
British India	11,000,000	7

During the five-year period Canada showed a decided increase and Mexico a decided decrease in output.

[4] "Mineral Resources of U. S., 1915." Part 1, p. 771.

TABLE 41.

AVERAGE ANNUAL PRODUCTION OF GOLD IN THE UNITED STATES FOR THE FIVE-YEAR PERIOD ENDING WITH 1917.[5]

State	Value (round numbers)	Rank
California	$21,300,000	1
Colorado	19,100,000	2
Alaska	15,800,000	3
Nevada	10,200,000	4
South Dakota	7,300,000	5
Arizona	4,400,000	6
Montana	4,000,000	7
Utah	3,600,000	8
Idaho	1,100,000	9
United States	92,000,000	

The nine divisions mentioned above produced nearly all of the gold mined in our country during the five-year period. The total value of gold mined in the Appalachian region for the same period was only about $100,000.

As pure gold is too soft to be durable, it is nearly always alloyed with copper or silver. Our gold coins contain one part of copper to nine parts of gold. Pure gold is seldom employed in the making of jewelry. There is a considerable demand for gold in connection with dentistry and photography.

Influences.—Gold has led to great developments in our Western States, in Alaska, South Africa and Australia. In each of these areas marked movements of population followed the discovery of gold. California's white population increased from about 12,000 in 1849 to practically 100,000 in 1850. The agricultural development of the area, its admission as a state, and its railroad connection with the East came about much earlier than they would have had it not been for gold. Alaskan gold led to the building of the White Horse Pass and Yukon River Railroad.

One of the great gold fields of Australia is situated in an arid region some 400 miles east of Perth. The mineral wealth could not be developed without transportation facilities and a water supply. A railroad was therefore built into the region, the towns of Coolgardie and Kalgoorlie established, and a great aqueduct laid for the delivery of water. There are many similar illustrations of the influence of gold and other forms of mineral wealth upon human life.

[5] Statistical Abstract of the United States, 1917, p. 231.

STUDIES

Make a list of at least 100 articles into the construction of which iron or steel enter. How do coke and limestone enter into the iron industry? How is the iron industry in Minnesota related to her educational interests? Why is steel more valuable than iron? Explain how steel ships float. Write a paper on man's relation to iron. Name the uses of copper. What is the silver in a silver dollar worth? Show how the gold has shaped the history of some area. How will the economic geography of France be changed by the restoration of Alsace-Lorraine to that country?

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CHAPTER XXXI

Miscellaneous Minerals

SALT

Occurrence.—Common salt or halite ($NaCl$) is one of the necessities of life. It contains 39.4 per cent. of chlorine and 60.6 per cent. of sodium. Salt occurs in the crust of the earth in a solid form known as rock salt. Such deposits occur where an arm of the sea or an inland body of salt water has disappeared as a result of evaporation. Salt also occurs in the rocks in the form of brine. From each 100 pounds of ocean water artificially evaporated, about three and one half pounds of mineral matter are obtained, most of which is common salt. The ocean is one of the chief sources of this mineral. Great quantities of salt exist in inland bodies of salt water, such as Great Salt Lake and the Dead Sea. Some few years ago it was estimated that Great Salt Lake contained 400,000,000 tons of salt.

Distribution and Production.—Salt is widely distributed. The United States, the British Isles, Russia, Germany, India, France, Japan, Austria, Italy and Spain are all large producers. Near Cracow, Austria, are rich deposits of rock salt 1,200 feet in thickness. So extensively is the salt mined that a small town exists hundreds of feet below the surface of the earth. Here are streets, stores, restaurants, a church and a theatre. The deposits belong to the government and have been worked for 1,000 years.

The chief salt-producing states in our country are New York, Michigan, Ohio, Kansas, Louisiana and California. Our total output of salt, which in 1903 amounted to nearly 19,000,000 barrels, increased to more than 49,000,000 barrels in 1918. The value of the output was in 1918 more than $20,000,000.

In the vicinity of Syracuse, New York, there are brines, and much rock salt also exists in the Mohawk valley. Near Saginaw, Bay City, St. Charles and Mt. Pleasant, Michigan, are deposits of a similar nature. Brines are pumped from a depth of more than 1,000 feet in West Virginia and Ohio. There is a large area of rock salt in central Kansas and the Louisiana product is of the same nature. The salt industry in central California is favored by relatively high temperature, high percentage of sunshine, low humidity and a clayey soil which makes a good bottom for the pans.

The Industry.—Salt springs were determining factors in the location of some of the early settlements on the western side of the Appalachian Mountains. The long haul across the mountains made salt expensive in areas where it could not be produced. Hence the salt industry was one of the earliest to develop. In speaking of the early settlement of the Trans-Allegheny region a well known writer says: "At first salt was imported at almost prohibitive prices; but soon the pioneer began to boil water from the saline springs which abounded, and later learned to bore for richer brine. At Bullitt's Lick on Salt River in Kentucky a regular industry was started, and supplied the frontier communities from the Ohio to the Cumberland."[1]

The production of salt in New York has been an important industry for more than a century. Most of the wells in the Syracuse area are the property of the state, as the land was formed into an Indian reservation in 1797. The following statement taken from Adams's Geography, page 130, published in 1824, is of interest: "Salt springs are frequent in different parts of the state. The most noted are those between Oneida and Seneca Lakes. . . . . . Here are two towns, Liverpool and Salina, wholly occupied in making salt. . . . The water is drawn up from wells by hand and by horse pumps. No other salt is used in the country, and a great part of the States of Pennsylvania, Virginia, Ohio and Michigan Territory, as likewise the whole Upper and a considerable part of Lower Canada, are wholly supplied from these works. These springs are the property of the state. Boats come within 4 rods of the works."

In some cases rock salt is mined. In other cases water is conveyed to it by means of pipes and the resulting brine pumped up. Much salt is obtained by evaporating sea water. Both solar and artificial heat are employed. Water from Great Salt Lake is pumped into wooden flumes, which convey it two miles to the ponds or pans. In the first of these the impurities settle. In the third the salt is deposited in a layer varying from two to six inches in thickness. About five months are required for the process. The salt is scraped up from the bottom of the pond and loaded on to cars.

Commerce.—The cost of production, and therefore the cost to the consumer, depends upon the source from which the salt is obtained, the methods employed, the cost of transportation, and the attitude of the government toward the industry. Salt is a government monopoly

[1] Semple, Ellen Churchill: "American History and its Geographic Conditions," page 82.

in Austria-Hungary, Italy and Turkey and as a result the commodity is expensive in these countries. The first cost of salt in the United States was in 1915 but $2.19 per ton; in Austria-Hungary it is more than $20.00. As a result, both production and consumption are relatively small in the latter country.

The cheap production of salt in the United States has had an important effect upon the meat-packing industry. Owing to cheap labor and water transportation the West Indies and the Mediterranean countries are able to compete with New York in supplying New England coast cities with salt. As a result of the reduction of the tariff through the Payne-Aldrich bill to $1.40 per ton, imports will probably increase. In 1915 we produced 99 per cent. of the salt consumed in our country. Both Great Britain and Germany are exporters of salt.

Uses.—In addition to the very universal use of salt in food as it is cooked and eaten, great quantities are used in packing and preserving fish, meat, hides, butter, pickles and hay. Farmers scatter it about in pastures for horses, sheep and cattle, and occasionally place it before stock during the winter. When mixed with ice, salt dissolves. The process of dissolving the salt requires heat. This principle is made use of in the manufacture of ice cream, for the dissolving of the salt used takes so much heat from the cream that it freezes. Salt is used in the manufacture of soda, glass, bleaching powder, pottery and in the refining of silver.

SULPHUR

Unlike salt, sulphur is not widely distributed. It is generally found in volcanic regions. The island of Sicily produces the greater part of the world's supply. Japan and the United States are the next most important producers, in the order named. In our country, Louisiana contributes the bulk of the sulphur not obtained from iron pyrite. Utah and Wyoming produce smaller quantities.

In Sicily the sulphur is sometimes piled up in heaps and ignited. The melted sulphur is caught and allowed to solidify through cooling. There are about one thousand sulphur mines in Italy and Sicily, yielding more than one half-million tons annually. The sulphur deposits of Japan occur on a volcanic island some two thousand miles north of Tokio. At present a part of the product is shipped to the Pacific Coast of our country.

In the southwestern part of Louisiana, near the town of Lake Charles, there is an extensive deposit of sulphur. It lies at a depth of six to eight hundred feet and this, together with the fact that there are great deposits of quicksand above it, makes it expensive to obtain the sulphur. Pipes are driven to the mineral and through these steam is forced down. This dissolves the sulphur, which is then pumped out. It is run into vats, where evaporation takes place. The product is then shipped. A single well sometimes yields from 400 to 500 tons of sulphur daily. As the sulphur flows from the wells it averages more than 99 per cent. pure. A very large part of the product goes to Sabine, Texas, from which point it is shipped by water to various Atlantic ports.

There are sulphur deposits in Utah, Nevada, California and Colorado, but these do not yield very extensively. Much sulphur in our country is obtained from pyrite.

Sulphur has many uses, one of the most important being in the manufacture of gunpowder. It is used in medicine, in vulcanizing rubber and in drying peaches, apricots and other deciduous fruits.

Sulphuric acid is used in the manufacture of glass, aniline colors, matches, kerosene, blue vitriol, green vitriol, alum and other things.

Sulphurous acid enters into the making of paper pulp and is used in bleaching and in disinfectants. As we have to depend in part upon Italy for our supply of sulphur, there is no duty placed upon it.

For the five years ending with 1914 our average annual production of sulphur was, in round numbers, 300,000 long tons, the average annual value of which was $5,000,000. There was a steady increase in output and value during the years mentioned.

MINERAL WATERS

For many centuries the waters of certain springs and pools in various parts of the world have been held in high repute because of their real or supposed medicinal value. The fame of these waters has led to the growth of towns and cities in their vicinity. Carlsbad, Austria; Baden, Germany; Vichy, France; Bath, England, and Saratoga, New York, are examples. Among the peoples of ancient times the Egyptians, Greeks and Romans made much use of mineral waters. During recent years great quantities of mineral waters have been drunk far from their places of emergence. The bottling, shipment and delivery of such waters is an industry of considerable importance.

The term "mineral waters" is somewhat misleading, as all ground water is more or less mineralized. The amount of mineral matter which water contains in solution depends upon the length of time which the water has remained underground, the temperature of the water and the character of the rock with which it has been in contact. If the percentage of mineral matter in the water is unusually high, or if it is particularly noticeable because of color, taste or odor, the water is called mineral water.

The average annual value of the domestic mineral waters sold in our country is about $5,000,000. More than 800 springs report sales. The average price per gallon at the springs ranges from one cent in Nevada to forty cents in Kansas. In 1915 the five leading states as to value of output were Wisconsin, New York, California, Maine and Virginia. In the value of medicinal waters California led, while Wisconsin held first place in the value of table waters.

Diamonds.—Of the many precious stones the diamond is the most important. It is pure carbon, and is the hardest substance known. Because of their hardness, diamonds must be cut and polished by means of diamond dust. Black diamonds, which are worthless as gems, are used as tips for rock drills.

Diamonds are found in various parts of the world, including South Africa, Brazil and India, but South Africa is the chief diamond-producing area in the world. The diamond mines near Kimberley produce millions of dollars' worth of these precious stones yearly.

The diamonds are obtained from a formation known as the "blue earth," and in some cases at least, appear to be in volcanic tubes. The diamonds are extracted from the dirt by a process of washing.

The United States furnishes the greatest market for diamonds. During periods of financial depression the sale of diamonds naturally falls off. At such times many of the diamond workers in Amsterdam and Antwerp, the chief centers for the cutting and polishing of the stones, are thrown out of employment.

STUDIES

What is the origin of the salt in the ocean? How many pounds of salt could be obtained by evaporating a ton of sea water? Is the water in rivers salt water? In what cities in the United States is there an unusually great consumption of salt? What are the chie uses of sulphur? Is all water mineral water?

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PART SIX

TRANSPORTATION AND COMMUNICATION

CHAPTER XXXII

TRANSPORTATION BY LAND

General Statement.—Modern life is absolutely dependent upon transportation and communication. For our daily food, for the clothes which we wear, for the materials of which our homes are constructed, for the countless manufactured articles used in all walks of life, for the means of getting to our daily places of business, we are dependent upon transportation facilities. When individual families and communities produced practically all of the essentials of life, transportation was not important, but the growth of cities, the specialization of labor and the development of areas far from markets make adequate transportation essential.

For how many centuries human beings were their own burden-bearers is not known. In time the ox, dog, horse, camel, elephant, yak, llama and other animals were pressed into service. All of these animals are yet made use of, the horse the most extensively.

With the invention of carts and wagons, the trails and paths used by porters and pack animals could not be employed. Hence these were widened and developed into roads. The Romans were the most celebrated road builders of ancient times. Their roads were chiefly used as a means of binding together the different parts of the empire. Some of these roads, both in Great Britain and upon the mainland of Europe, are today followed by railroads. When the Spanish first visited Bolivia and Peru they found that the natives had constructed good roads through the mountainous regions. These roads, like those built by the Romans, were for military purposes.

Early Roads in the United States.—In the United States the Appalachian Barrier confined settlement to the Atlantic Coastal Plain for a long time. As this region is well supplied with rivers the needs of the people were fairly well met by water transportation. When the great domain lying west of the Appalachian Mountains was made known by hunters, trappers and traders, there began the westward expansion of our population.

For a time the settlers crossed the mountains on foot or horseback, but the necessity for roads steadily increased. Then as now, the easiest grade was found by following the Hudson-Mohawk route, and a wagon road was constructed along this old war trail.

In the year 1753 George Washington made a trip on horseback from Williamsburg, Virginia, to Fort le Boeuf, near where Erie, Pennsylvania, now stands. The journey required 42 days. At the present time the trip can be made in less than a day.

For a time the government did some road building. The "Old Cumberland Road" was commenced in 1811 and opened to Wheel-

Photo by C. C. Pierce.

FIG. 145.—A mountain trail.

ing, Virginia, in 1818. As surveyed, the route was about 700 miles in length, connecting Cumberland, Maryland, with Jefferson City, Missouri. It was in part completed to Vandalia, Illinois. The policy of government road building was soon discontinued and the work in large measure fell upon companies. This involved the levying of tolls and such roads were called "toll roads."

Wagon Roads of the Present Day.—Wagon roads are of tremendous importance even in this age of railroads, for they are the feeders of the railroads. The load which a horse can draw depends upon the grade and upon the nature of the roadbed. As the character of the road determines, in large measure, the cost of marketing commodities, people have in recent years given much attention to the improvement of roads. Some country roads are graveled, some oiled and some macadamized.

In 1916 there were in the United States more than 2,000,000 miles of wagon roads and 10 per cent. of the total mileage was improved. In the same year we had about .75 mile of road to each square mile of area, and one mile of road to 41 inhabitants. The people of the United States spent upon their roads in the year 1916 about $250,000,000.

Great Britain, Germany and France have excellent roads, but Russia is very deficient in roads. The season during which roads can be used by wagons in Russia is short, especially in the north, and during a part of this time the land is so wet as to make the roads

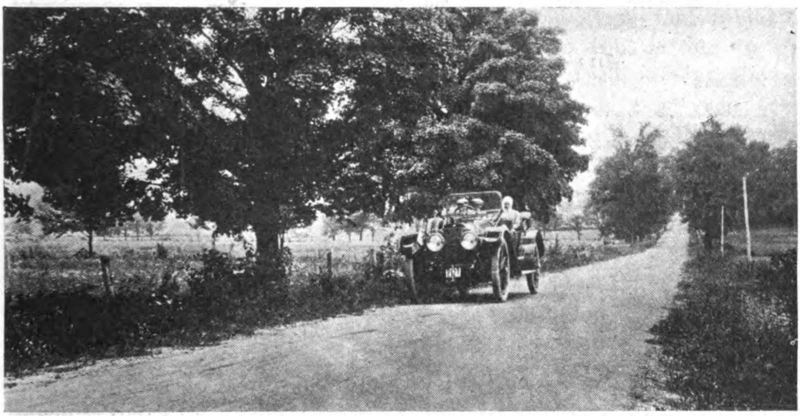

FIG. 146.—New Jersey state road. (U. S. D. A.)

practically impassable. Another reason for poor roads is the lack of good road-building material. Then again, the people are poor and the government has not encouraged road building.

China also is lacking in roads. This is chiefly due to the fact that the very dense population makes it difficult to produce the food necessary for draft animals. The most dense population is found upon the great plains, and here navigable rivers and canals serve as routes for transportation. Upon land, porters are largely employed and the wheelbarrow is extensively used.

Railroads.—The application of steam to transportation has revolutionized industry and commerce and led to the rapid settlement and development of new areas. Macaulay says: "Of all inventions, the alphabet and the printing press alone excepted, those inventions which abridge distance have done most for civilization."

A locomotive was first employed in Great Britain about 1804 for the purpose of hauling coal from the mines. This locomotive was made by Richard Trevithick. In the year 1825 George Stephenson ran a train carrying both coal and passengers at the rate of 15 miles per hour. As early as 1829 passenger trains were used in England between Liverpool and Manchester.

The first railroad was constructed in the United States in 1826. In 1853 one could travel from the Atlantic coast to Chicago without change. It was not until 1869, however, that California was connected with the Mississippi valley and the East by rail. The marvelously rapid development of railroad building in the United States is shown by the following table:

TABLE 42.

MILES OF RAILROAD IN THE UNITED STATES.[1]

Years	Miles
1830	23
1840	2,818
1850	9,021
1860	30,626
1870	52,922
1880	93,262
1890	167,191
1900	198,964
1910	249,992
1916	266,031

In 1918 the United States had about one-third of the total railroad mileage of the world. The relation between railroad mileage and area in certain countries is shown by Table 43.

TABLE 43.

RELATION BETWEEN RAILROAD MILEAGE AND AREA[2]

Country	Miles of road to 1,000 square mile
Belgium	479.3
Switzerland	224.0
United Kingdom	195.2
Germany	189.6
Denmark	164.2
Holland	160.1
France	154.8
Austria-Hungary	112.3
United States	77.3

[1]Statistical Abstract of the United States, 1917, p. 297.

[2]Statistical Abstract of the United States, 1917, pp. 772, 773.

Country	Miles of road to 1,000 square miles
Spain	53.5
Russia	5.9
China	1.5
World	721,397.0

When we compare mileage and population, the United States outranks Belgium.

Improvements in Railroad Transportation.—Cost, speed and safety are the three vital factors in transportation. In 1876 it cost 16.50 cents per bushel to ship wheat by rail from Chicago to New York. In 1917 the cost was 9.18 cents. In 1837 the average cost per ton-mile in the United States was 7⅓ cents. In 1905 this had fallen to .80 and in 1916 to .71 cent. The decrease in cost is due to the lowering of grades, the elimination of curves, to the increase in the load hauled by one engine and to competition.

The increase in speed is of vast importance in marketing fruits, vegetables and milk. Rapid transportation makes it possible for people in the Central and Northeastern States to enjoy fresh fruits and vegetables grown in Florida. Very rapid fruit specials are run from California to the East, carrying oranges. These trains average about 13 miles per hour. It should be remembered that much of the country crossed is very mountainous. Rapid transportation as applied to the milk supply can hardly be overestimated.

Increased safety is of great importance. Better roadbeds, more substantial cars, improved couplers, airbrakes, a better service in dispatching trains, double track and more intelligent employees have resulted in a decrease in loss of life and property.

In 1916 the railroads in our country carried about 2,200,000,000 tons of freight. There were more than 2,000,000 freight cars in use, the average capacity of which was 40 tons. This shows the importance of railroad transportation. Without this system, land far removed from the great centers of population would be practically valueless, for crops could not be marketed at a profit. Our railroads are important in the transportation of people as well as freight. In 1850 the population of the United States was 23,191,876. In 1920 it had grown to about 110,000,000. In addition to this great increase in population, there has been an increase in the number of miles traveled per capita. Travel on account of business, health and pleasure has increased enormously.

Routes and Topography.—Topography has played an important part in guiding the construction of railroads in all countries. The relationship is, of course, much more important in mountainous than in level countries. Although the passes across the Appalachians are not high, they are factors of no slight consequence. The New York Central and Hudson River Railroad has the lowest pass, the altitude being about 445 feet.

Across the prairies and plains roads were built with little regard to surface features. On reaching the foothills of the Rocky Mountains, however, valleys guided the routes. For a considerable distance the Southern Pacific follows the "Gila Trail." Similarly, the Santa Fé follows the trail of the same name, the Salt Lake Road the "Spanish Trail," the Central Pacific the "California Trail," and the Oregon Short Line the "Oregon Trail."

TABLE 44.

TOTAL LIFT FOR EAST- AND WEST-BOUND TRAINS BETWEEN THE ONE HUNDREDTH MERIDIAN AND THE PACIFIC COAST.[3]

Railroad	Miles from 100th meridian to the Pacific Coast	Lift west-bound	Lift east-bound
Great Northern	1,362	7,021 ft.	8,588 ft.
Northern Pacific	1,510	7,082	8,962
Union Pacific	1,541	10,978	13,460
Santa Fé	1,749	15,066	17,546
Southern Pacific	1,798	10,759	11,756
Chicago, Milwaukee and Puget Sound	1,390	11,202	12,861

The Union Pacific was opened in 1869, the Southern Pacific in 1882, the Northern Pacific and the Santa Fé in 1883 and the Great Northern in 1893. The difficulties in constructing our transcontinental roads were enormous. We lacked equipment. Much of the region was poorly provided with water and Indians were a source of danger. Vast sums of money were necessary and dividends could not be paid for years, since the railroads must bring in the population and create the business. Because of these conditions, the government gave great tracts of land to each of several transcontinental railroads.

The Atlantic and the Pacific coasts of Canada are now connected by rail, as are the same coasts of the Russian Empire. The English are building a road across Africa from Cape Town to Cairo. Construction is progressing from both the north and the south, but

[3] Parkins, A. E.: *Jour. of Geog.*, vol. viii, p. 109.

there yet remains a long gap in the central part of the continent. Recently a railroad was finished from Perth, Australia, to Port Augusta. It is now possible to travel by rail from Perth to Townsville, a distance of about 4,000 miles. The eastern and the western coasts of South America were connected in 1910, when the Transandine Railroad was opened. This road connects Buenos Aires and Valparaiso, and the trip between the two points can be made in about 40 hours.

Cities have special transportation problems. The congestion upon the streets has led to the construction of both elevated roads and subways in a few cities. In both city and country electric cars are used in great numbers. These have done a great deal toward solving the transportation problem for those whose business is in a city and whose residence is in the suburbs. One can now make long as well as short trips by means of electric cars.

In considering the problem of transportation by land, the automobile must not be omitted. It has been a prominent factor in revolutionizing country life and much of the trucking in cities, as well as the transportation of passengers, is done by auto-vehicles. Automobiles are now used upon the deserts in the western part of our country and upon the Sahara, thus greatly reducing the danger on account of water shortage. Auto-vehicles played an important part in the great war which began in 1914. Good roads led to an increased use of automobiles, and on the other hand the use of automobiles has done much to bring about better roads. In 1920 it was estimated that there were some 10,000,000 automobiles and auto-trucks in the world, about three-fourths of which were in the United States.

STUDIES

Why have toll roads and toll bridges practically gone out of existence? How do good roads contribute to the development of an area? Why has so much attention been given to good roads in recent years? Compare the mileage of railroad per unit of area in Belgium and Holland. Account for what you find. Has government ownership of railroads been a success? What industries are largely dependent upon railroads? Show how wagons and railroads are guided by surface features in your vicinity. Make a study of road improvement in your state. Is the Federal Government aiding in road construction in your vicinity?

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CHAPTER XXXIII

INLAND WATERWAYS

General Statement.—At a very early period man commenced to make use of streams as routes of trade and travel. Their use preceded the construction of roads, and their importance steadily increased until the era of railroad building began. Vast sums of money have been spent on river improvement and on canal construction. Inland waterways are prominent factors in the economic geography of many countries, but so great is the importance of time in the affairs of the world today, that practically all of the passenger and much of the freight business has been taken over by the railroads. Bulky and non-perishable commodities are the only ones shipped extensively by inland waterways.

Inland Waterways in North America.—Rivers as trade routes are treated in Chapter XI, hence the present chapter will deal especially with canals. According to the report of the Inland Waterways Commission there are in the United States 295 navigable rivers, and more than 26,000 miles of navigable river waters, and much improvement is contemplated. The Mississippi and its tributaries furnish more than 13,000 miles of navigable waters. The commission above referred to attempts to maintain between New Orleans and St. Louis a channel 250 feet wide and 9 feet deep. The Hudson, although short, is a waterway of great importance. None of the rivers west of the Mississippi is as yet of great commercial value. More than 4,000 miles of canal have been constructed in our country, much of which has gone into disuse. The Erie Canal (now Barge Canal), which has been recently improved at enormous cost, is of great importance because it connects the Great Lakes with the navigable Hudson. The Chicago Drainage Canal is of sufficient size to admit large ships, but will be of little commercial value until the Illinois and the Mississippi Rivers have been deepened. Two canals of some importance cross the State of Ohio, connecting Lake Erie with the Ohio River. All these waterways are treated elsewhere. The Panama Canal, one of the greatest waterways in the world, is discussed in Chapter L.

The value of the St. Lawrence is enormous, because it and the Great Lakes afford a deep-water route between the heart of the continent and the Atlantic seaboard. The Sault Ste. Marie Canals connect Lake Superior and Huron. One of the canals is a Canadian waterway and the other belongs to the United States. Both canals carry a very large tonnage, although they are ice-bound for about half of each year. The canal belonging to our country is the more important of the two. The Welland Canal, by means of which Canada's lake commerce is carried around the Niagara Falls, connects Lakes Erie and Ontario. It has a depth of 14 feet. A canal connecting Georgian Bay and the Ottawa River has long been a proposed improvement. This would greatly decrease the distance between Lake Huron and the Atlantic coast.

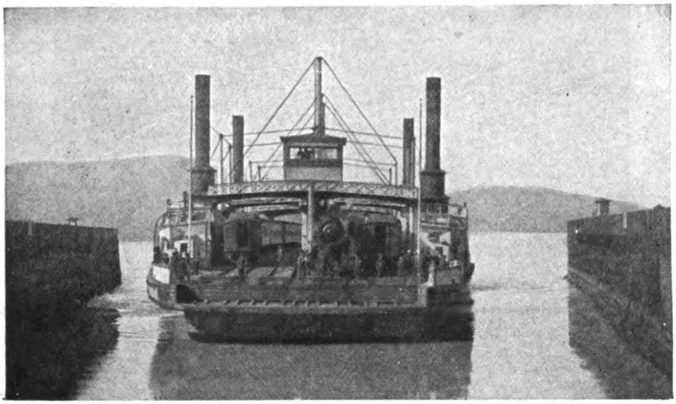

FIG. 147.—River transportation.

Inland Waterways in Europe.—Although the area of the British Isles is much less than that of Montana, more than 3,000 miles of canal were constructed, chiefly before the era of railroad building began. Much of this mileage is now in disuse.

The Manchester Canal is one of the important canals of the world, although only 35½ miles long. It follows the Mersey River, and connects Liverpool with Manchester. A great deal of raw cotton is shipped by this canal. The long estuary of the Humber and the relatively slight relief of the country made it possible to connect Liverpool and Hull by canal.

France is well supplied with navigable rivers, and because of favorable surface conditions many canals have been constructed. About one-fourth of the internal trade of that country is carried on by means of inland waterways. As the canals are for the most part controlled by the government, the rates are low.

By means of the Canal du Midi, 150 miles in length, the Garonne and the Rhône are connected. Although the canal is shallow, it carries considerable tonnage. All of the large rivers are united by canals, and several of the rivers of France are connected with the Rhine.

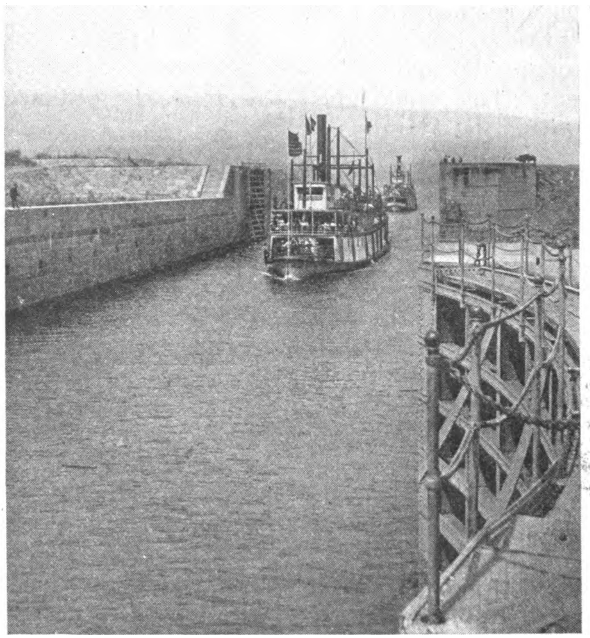

Photo by Chamberlain.
FIG. 148.—A lock in a canal.

Belgium and Holland are very important commercially. This, and the flatness of the countries, have led to the building of many canals. These, and the navigable Meuse, Scheldt and Rhine, carry a very large tonnage.

Western Germany is a plain drained by navigable rivers which are connected by a network of canals. In Germany there is no antagonism between rail and water routes, for both, in large measure, are in the hands of the government.

The Rhine is the most important waterway in Europe. Large sums have been spent in deepening it and in reducing curves. On the average navigation is interrupted annually for only 6 weeks. As has been shown, the Rhine is connected with several other important rivers, and its value is increased by the fact that it traverses a region in which there is much industry.

Of the many canals of Germany, the Kiel Canal may be mentioned. This crosses the base of the peninsula of Jutland, and affects a saving of two days between Baltic and North Sea ports of Germany. The canal has military as well as commercial importance.

Much of Russia is a plain, and as a result many of the rivers have low gradients, and are navigable for long distances. Numerous canals have been constructed, and others are contemplated. The long, severe winters greatly lessen the value of the waterways. The St. Petersburg and Kronstadt Canal, which was opened in 1890, gives Petrograd water connection with its port.

Inland Waterways in Africa.—All of the great rivers of Africa are obstructed by rapids in their lower courses, although navigable in their middle courses. On this account transportation between the coast and the interior is much more expensive than it would otherwise be. As the continent has experienced comparatively little industrial development, not much attention has been given to the improvement of the waterways. The Nile affords the easiest means of reaching the interior by water, although the navigation of this river is hindered by rapids.

In 1869 the land bridge which for ages had united Asia and Africa was severed by the opening of the Suez Canal. The length of the canal is 87 miles, about 20 of which are in Great Bitter Lake and other bodies of water. At the Mediterranean end of the canal is Port Saïd, and at the southern extremity Suez is situated. The Suez, unlike the Panama Canal, is a sea-level waterway. It has a depth of about 28 feet, which enables it to accommodate ships of large size. Through the use of a system of block signals and electric lights, the canal is used by night as well as by day. Owing to the mild climate, the canal is used at all times of the year.

The opening of the canal immediately diverted much commerce from the Cape of Good Hope route, because it shortens by thousands of miles the distance between western Europe and the Far East. As England carries on an extensive commerce with India, Australia, and New Zealand, the canal is of special importance to that country.

Inland Waterways in China.—The great plain of China is traversed by navigable rivers, and the people have constructed many connecting waterways. In part because of the large numbers of persons to the square mile, there are few horses, hence few roads. This gives an added importance to the waterways. The longest of the canals is the Grand Canal, which connects Ningpo with Tientsin.

Inland Waterways in Australia.—Australia is so deficient in rainfall that there is in the entire continent but one river (the Murray-Darling) which is of any considerable value from the standpoint of navigation. This is the one continent in which inland waterways can never assume much importance.

Inland Waterways in South America.—South America has three magnificent river systems: the Orinoco, the Amazon and the Parana. These rivers and their tributaries have already been of much value in the development of the continent. As the era of railroad building had commenced before South America began to develop extensively, little attention has been given to the improvement of waterways.

STUDIES

Give several reasons why transportation by inland waterways is cheaper than transportation by rail. Why has more attention been given to inland waterways in Europe than in the United States? Explain the purpose of locks, and show by means of a diagram how they work. Make a study of the nearest navigable river or canal.

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CHAPTER XXXIV

Ocean Transportation

General Statement.—For untold centuries the sea was an absolute barrier to the movements of man. He could creep along the shore in boats propelled by oars, but he dared not venture beyond the sight of land. As early as 1500 B. C., however, the Phœnicians were freely navigating the Mediterranean Sea. These people originally occupied a narrow strip of country at the east end of that sea, and the numerous islands and slight tidal range favored the development of ocean navigation. About 1,000 years before the beginning of the Christian era the Greeks became noted as a seafaring people.

The invention of the keel and the mariner's compass did much to encourage, and make safe, long voyages. The use of steam has revolutionized ocean travel. Columbus was 70 days in making his first voyage to America. In 1819 the steamship *Savannah* was 22 days in making her first trip from the city of the same name to Liverpool. Today it is possible to make the trip from New York to Liverpool in five days. A trip around the world is no longer considered an unusual thing, and traveling upon the sea is safer than traveling upon the land.

Ocean Routes.—Land routes of travel are largely determined by topographic features. Other things being equal, the greater the lift between two points the greater the cost of transportation. Upon the ocean there are no grades to be overcome. Configuration, however, is an important factor. The fact that North and South America were united by a land bridge, as were Asia and Africa, necessitated long voyages around Cape Horn in the one case and the Cape of Good Hope in the other. The opening of the Suez Canal in 1869 and the Panama Canal in 1914 brought about great changes in ocean routes and hence in cost of transportation.

Before the days of steamships, the prevailing winds were quite important in shaping routes. It was customary to make the voyage from northeastern Africa to India during the summer season and thus take advantage of the summer monsoon. The return trip was made in the winter, when the northeast monsoon would drive the ship homeward. Today the winds are not important factors in determining ocean routes.

Similarly, ocean currents exerted a marked control. Ships sailing from Europe to the United States often sailed southward along the west coast of Africa until the trade wind belt was reached. From this point the winds and the equatorial current both drove the ship on.

Although waves do not determine routes of travel, they are definitely related to the movements of vessels. Ordinarily, even during storms, the distance between adjacent wave crests or troughs is not over 600 feet. Vessels more than 600 feet in length do not therefore pitch and roll as much as do shorter ones. Partly on this account the tendency is to construct ships much longer than they were a few years ago.

When oil is poured upon the surface of the water it forms a film between which and the wind there is much less friction than there is between the wind and the water. This is why oil lessens the height of the waves. The large ships of the present day carry oil for this purpose.

Temperature plays a part in modifying ocean routes. During the summer icebergs drift southward in the North Atlantic Ocean and are a menace to ships. At this season, vessels, as a rule, adopt a course south of the winter route. During the winter the northern routes are free from ice. On account of ice, many harbors are closed for several months at a time and this results in a temporary change of routes. Montreal, for example, is ice-bound between December first and May first. During this time Halifax, Nova Scotia, and Portland, Maine, secure the commerce which would otherwise pass through Montreal.

Determining Position at Sea.—Upon the open ocean there are no landmarks. Because of this, it was hazardous, before the days of the mariner's compass, to venture far from land. Exact location at sea is determined by ascertaining the latitude and longitude of the ship.

The captain or other officer makes daily observations and records the latitude and longitude of the vessel. If a ship is met or passed, the position is noted. Should a rock, shoal or island not charted be discovered, its position is recorded.

At sea latitude is usually obtained from the sun by means of an instrument known as the sextant. At the instant when the sun is on the meridian the altitude of the former is taken. Tables show the declination of the sun, that is its distance north or south of the celestial equator. If the observation is being taken in the northern hemisphere and the sun's declination is south, the amount of declination is added to the altitude of the sun and the result subtracted from 90°. This gives the altitude of the position. North declination is subtracted from the altitude. When observations are taken south of the equator, declination south is *subtracted* and declination north is *added.*

Longitude can be obtained by means of a watch. The timepieces which ships carry for this purpose are known as chronometers and they register the mean solar time of some specified meridian. When the shadow points directly north, that is when it is noon by the sun at a given position, let us suppose that the chronometer, which registers London time, shows that it is three o'clock in the afternoon. As time travels westward, the ship is west of London. As local solar time is three hours slower than London time, the ship is 45° west of London. The longitude of London is 0° and therefore the longitude of the ship is 45° west. This result is *approximately* correct. To get the exact longitude the observer must know whether the sun is fast or slow and how much.

Harbors.—Sea routes, like railroads, require good terminals. In the case of ocean routes these terminals are, of course, harbors. A rising coast is a regular one and hence deficient in indentations and projections. The harbor at New York and the one at San Francisco are examples of harbors created by a subsidence.

In these days of large ships depth of water is a point of the utmost importance. The depth of water required by the largest ships is steadily increasing, hence many harbors have to be deepened or the seaports situated upon them lose some of their commerce. The average depth required by the largest ships in the world has practically doubled since 1850 and is now about 40 feet. The rapid increase in the length of ships calls for larger harbor space.

The value of a harbor is in many cases determined by the tidal range. Twice each day, in response to the combined attraction of the moon and sun, the waters of the ocean rise and fall. This attractive force, which is known as *gravitation,* is exerted by each heavenly body upon every other. The power of this attraction varies inversely as the square of the distance, and directly as the product of the masses. The distance between the earth and the sun is approximately 93,000,000 miles, but the moon is only 240,000 miles from the earth. Therefore, although the mass of the sun is about 26,500,000 times that of the moon, the latter is the more important in the production of tides. In the open ocean the rise and fall of the tide is but one or two feet and there it has no relation to shipping.

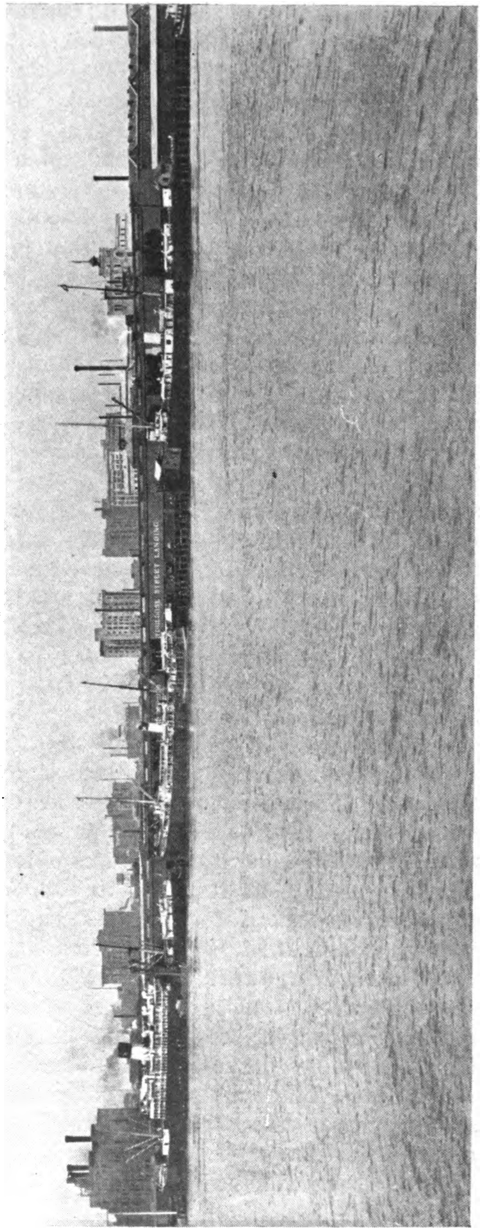

Fig. 149.—Harbor of New Orleans. (Courtesy of Convention and Tourist Bureau, New Orleans.)

The moon revolves about the earth from east to west in about 29 days, and the tidal movements, when not hindered by the configuration of the continents, take the same course. As the tidal wave moves through the ocean there is little transference of water. It is the *motion* that is transmitted from point to point. This is illustrated by the wave-like motion that runs across a field of wheat as the wind bends the stalks. When the tidal wave encounters shallow water near shore the motion is retarded on the sea floor but not at the surface of the water. Therefore the water piles up on the surface. When the tidal movement enters an estuary the converging shores contract the wave, which is, as a result, increased in height. When the tidal movement passes into a large bay or sea through a narrow opening, the wave spreads out upon entering the larger body and so decreases in height.

In estuaries which face the direction from which the tidal wave is advancing the tidal range may be 10, 20, 30 or even 50 feet. On this account a ship may be able to enter or leave a harbor at high tide which could not do so if the range were slight. Liverpool, Bristol, Southampton, Antwerp, Rouen, Hamburg and Philadelphia are illustrations of harbors which owe their importance in part to tidal range.

It is evident that it is of the greatest importance to the mariner to know just when high and low tide occur at given points and what the depth of water will be. Tide tables giving this information are published by many nations having seacoast.

Owing to the way in which projections and islands interfere with the movement of the tidal wave, high tide may occur in one part of a bay or strait at the same time that low tide occurs in another. The resulting difference in the level of the water gives rise to rapid movements called *races*. The Strait of Messina, the Strait of Magellan and the north coast of Scotland are illustrations.

Large sums of money are expended in sounding and charting the waters of the harbors and of the open ocean. Pilots depend upon these charts in navigating. Unless the charts are kept up to date they are valueless, as a large number of rocks and shoals are discovered annually. Scores of soundings may be made in a harbor and yet fail to reveal the presence of some rock which is a menace to ships.

In 1902 the United States cruiser *Brooklyn* struck a rock in Buzzards Bay having only 18 feet of water over it, although the charts showed that it was surrounded by 30 feet of water. In the same year a rock was discovered in New York Harbor. Although the depth all around the rock was 50 feet, the rock was covered by but 27 feet of water. In 1884 the steamer *Pilgrim* was injured by striking a rock in East River. Only 13 feet of water covered the rock.

In recent years a wire drag submerged to a known depth is used to draw through the water. This strikes every rock and shoal covered by less water than the given depth. By this process a rock was discovered in Blue Hill Bay on the coast of Maine having but seven feet of water over it and being but six feet in diameter at the top. The water surrounding the rock had a depth of 78 feet.

The value of a harbor depends in part upon its connection with the back country. New York, for example, is at the seaward end of the easiest route from the Atlantic seaboard to the interior of the United States. As a result a large part of our commerce passes through this city. San Francisco Bay leads directly into the interior of California and consequently more commerce centers upon its shores than in any other section of the state.

Ocean transportation has developed wonderfully. The map facing page 368 shows the chief routes. At all times of the year ships are following these routes distributing the products of the different countries in all parts of the world and carrying large numbers of people. For a number of years past, approximately 1,000,000 immigrants have landed upon our shores annually. This represents but a small part of the total number of passengers carried upon the ocean.

STUDIES

Describe the improvements which have been made in ocean navigation. To what extent are sailing vessels still used? How many carloads of freight can be carried on a great ocean liner? What changes in harbors has been made necessary by the increased size of ships? Why is transportation by water so cheap? Why has Great Britain such an important merchant marine? Locate the greatest seaports of the world. Show the influence of the Panama and the Suez Canals upon ocean commerce.

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CHAPTER XXXV

Aerial Navigation

The ease and grace with which birds move through the air has for centuries attracted the attention of men, and they have longed for the time when they too would be able to navigate the air. When the first experiments with balloons were made is not known, but the first which had any practical result was that of the brothers Stephen and Joseph Montgolfier in November, 1782. These young Frenchmen caught the idea of employing heated air to lift bodies as they were observing smoke ascending in a fireplace.

In the first experiments only paper bags were used. Later a larger balloon was made, and a duck, a chicken and a sheep sent up. The next year two men made an ascent, and landed in safety. About a year later the English Channel was crossed in a balloon.

The use of balloons rapidly increased from this time, and many long journeys were made. During the siege of Paris the people of the city kept in communication with the outside world by means of balloons. They were used quite extensively during our Civil War.

Through balloon ascensions a great deal has been learned concerning the conditions of the atmosphere at considerable altitudes. During recent years self-recording instruments have been carried by small balloons to great altitudes. Some of these instruments have been picked up, and thus data accumulates. An Italian balloon carrying instruments reached the altitude of 23 miles.

In 1862 Glaisher and Coxwell ascended in a balloon to a height of 7 miles, reporting a temperature of —60° F. This is no doubt the greatest elevation ever reached by human beings. In 1897 Andrée and two companions embarked in a balloon on a trip to the north pole. The fate of the voyagers is unknown.

In October, 1900, a balloon traveled from Vincennes, France, to a point in Russia 1,193 miles distant. Ten years later a contest among balloonists took place in the United States. The balloons started from St. Louis and landed in many different places; one in New Jersey, and another near Quebec, 1,171 miles from the starting point.

The difficulty with the spherical balloon is that there are no means of guiding it. This can be accomplished only when it is driven at a speed greater than that at which it would be carried by the wind. The dirigible has now been in use for several years. Some of these balloons can carry a considerable number of passengers.

Since 1898 airships or flying machines have been in use. In that year Santos Dumont, a Brazilian, succeeded in flying around the Eiffel Tower. Since that date a large number of persons have used flying machines. Beginning with the year 1903 the Wright brothers made many flights. In 1909 a French airman, Blerfot by name, flew across the English Channel. In 1910 Hoxsey, at a contest held in California, rose to the altitude of 11,974 feet, but fell to his death. The next year a French aviator flew from London to Paris in 4 hours.

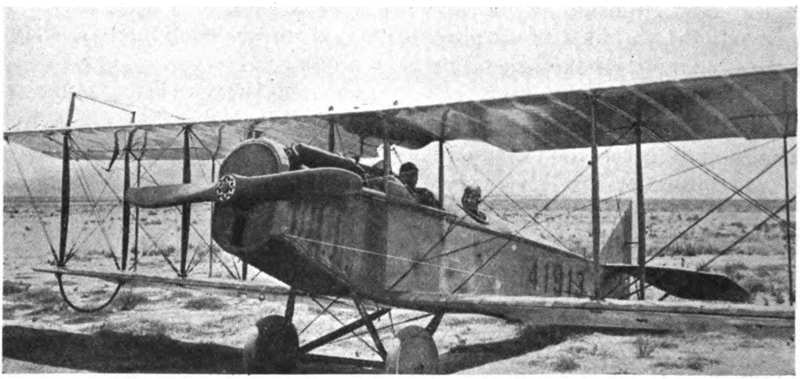

FIG. 150.—United States Army Air Service airplane. (Courtesy Ford A. Carpenter.)

Airships figured quite prominently in the European war which began in 1914. They were used to spy out positions, to carry dispatches, and in bombarding. In 1919 the first airship crossed the Atlantic Ocean. Air mail service between New York and Washington began in 1918, and mail is now being carried across the continent. To a limited extent passengers are being transported.

STUDIES

How are balloons made? Why is hydrogen gas used? Why are not airships as practical as are automobiles as a means of transportation? How are airships likely to be of value?

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CHAPTER XXXVI

Communication

General Statement.—The desire to communicate rapidly is almost as great as is the desire to ship commodities or to travel expeditiously. Modern methods of doing business would be impossible without the means of rapid communication. Goods are bought and sold, trains are operated, storm, frost and flood warnings are disseminated and lives saved at sea because of our system of rapid communication.

Primitive Means.—The first method of spreading news was by word of mouth. This meant that people on foot, or at a later time on horseback, carried the messages. When Cortez landed upon the coast of Mexico, in 1519, runners carried the news to Montezuma in his capital, where now is the City of Mexico. You remember that Paul Revere rode from town to town on horseback carrying the news of the landing of the British at Charlestown. In 1846 Kit Carson rode on horseback from California to Washington bearing dispatches.

Signal fires and noises have been employed for a long time as a means of notifying people of danger or of calling them together for any purpose. Crude drums made by hollowing out logs have often been used, as the sound can be heard for a long distance.

Mail Service.—For thousands of years letters have been written, but until recent times they were delivered by messengers traveling on foot or on horseback, or by carrier-pigeons. On January 1, 1676, the first regular mail service in America was established. This was for the purpose of handling the mail between New York and Boston. In the winter the round trip required one month. As late as 1704 there was no post-office west of Philadelphia. On July 26, 1775, Benjamin Franklin was appointed Postmaster-General at a salary of $1,000.00 per year.

Postage in Colonial times was high. For a long time there were no stamps, the amount due for delivery of the letter being stamped on the outside. James Chalmers, of Dundee, Scotland, made the first adhesive stamps in 1834.

Until 1869 there was no railroad connecting the Atlantic and Pacific coasts of our country, and of course the sending of news across continent or around Cape Horn was a slow process. To remedy this condition the Pony Express was started on April 3, 1860. For a time the rate of postage was $5.00 per half ounce between Iowa and California. Later the cost was reduced to $1.00. The time required to make the trip was from 8 to 9 days.

In 1790 there were in the United States but 70 post-offices. In 1920 there were about 54,000. There were nearly 20,000 more than this in 1901, but the growth of the rural free delivery system reduced the number.

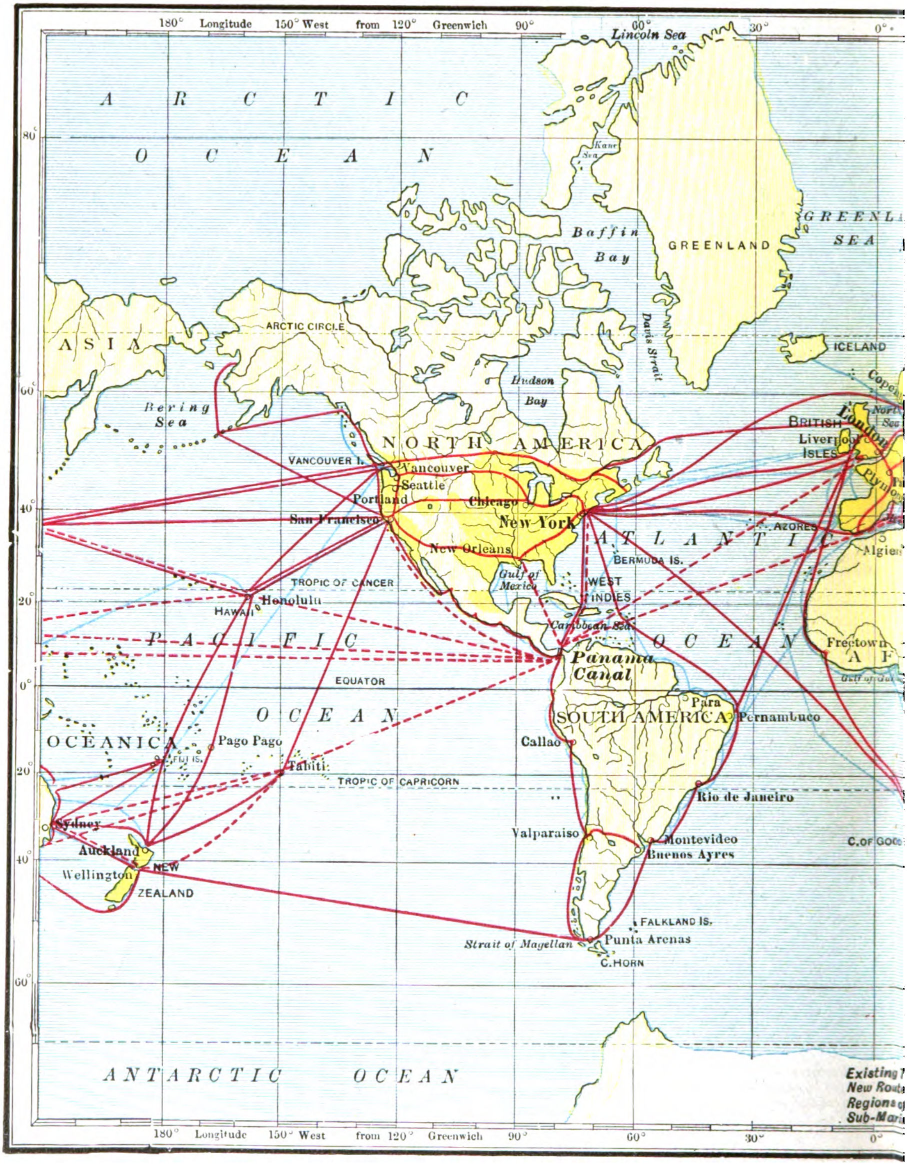
The mail is now carried on the fastest trains and steamships. The cost of carrying a letter from the United States to Europe or Asia is but five cents, and the postage between the British Isles and the United States is but two cents.

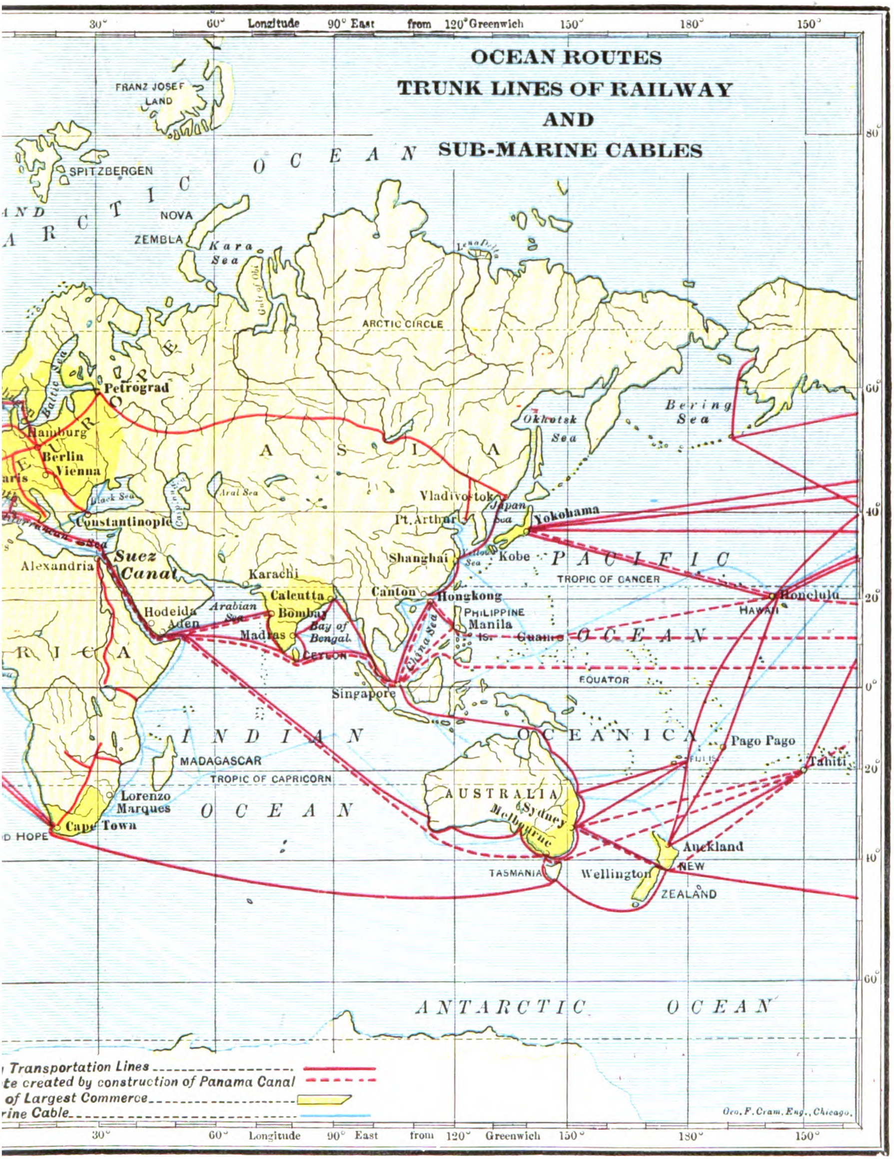
The Telegraph.—In 1840 Mr. Morse obtained a patent on his invention of the telegraph, and on March 4, 1843, Congress appropriated the sum of $30,000 to help him establish a line between Baltimore and Washington. In 1846 the dispatching of trains by telegraph began. The lines of the Western Union Telegraph Company now reach every section of our country and many millions of messages are annually sent over them. Business activities of all kinds are closely related to telegraphy. Wireless telegraphy is one of the marvels of the age. Vessels equipped with wireless outfits can establish communication between themselves and distant ships or the shore. Many lives are thus saved annually when ships collide with one another, with icebergs, or meet with accident from some other source.

On October 10, 1907, the steamship *Lusitania* communicated with Newport, Rhode Island, although far out at sea. On January 28, 1917, the naval radio station at San Diego, California, talked with Arlington, Virginia; Panama; Nome, Alaska; Honolulu and Australia. This indicates the importance of this wonderful means of communication.

The Telephone.—On February 14, 1876, two men, Alexander Graham Bell and Elisha Gray, made separate applications for patents on the telephone. On October 9, of the same year, Mr. Bell telephoned from Boston to Cambridge, a distance of two miles, talking with Thomas A. Watson, the maker of the first instrument used in telephoning. On January 25, 1915, the same gentlemen again talked with one another over the telephone, but Mr. Bell was in New York City and Mr. Watson in San Francisco. Although separated by 3,400 miles of mountains, deserts and plains, they conversed without difficulty, a wonderful proof of the triumph of science.

The telephone plays an important part in the work of today, for by means of it an individual can keep in touch with his force of clerks and other helpers. Much important business is transacted by telephone, and a great deal of the family marketing is now done in this


180° Longitude 150° West from 120° Greenwich 90° 60° 30° 0°
Lincoln Sea
ARCTIC OCEAN
Kane Sea
Baffin Bay
GREENLAND
GREENLAND SEA
Davis Strait
ICELAND
ASIA
ARCTIC CIRCLE
Hudson Bay
Bering Sea
NORTH AMERICA
VANCOUVER I.
Vancouver
Seattle
Portland
Chicago
San Francisco
New York
New Orleans
BRITISH ISLES
Liverpool
London
North Sea
Plymouth
AZORES
ATLANTIC
BERMUDA IS.
Gulf of Mexico
WEST INDIES
Caribbean Sea
TROPIC OF CANCER
Honolulu
HAWAII
PACIFIC
OCEAN
Panama Canal
Freetown
EQUATOR
OCEAN
Para
SOUTH AMERICA
Pernambuco
OCEANICA
Pago Pago
FIJI IS.
Callao
Tahiti
TROPIC OF CAPRICORN
Rio de Janeiro
Sydney
Valparaiso
Montevideo
Buenos Ayres
C. OF GOOD
Auckland
NEW ZEALAND
Wellington
FALKLAND IS.
Strait of Magellan
Punta Arenas
C. HORN
ANTARCTIC OCEAN
Existing
New Route
Regions
Sub-Mari


OCEAN ROUTES
TRUNK LINES OF RAILWAY
AND
SUB-MARINE CABLES
30°
60°
Longitude
90° East
from
120° Greenwich
150°
180°
150°
80°
60°
40°
20°
0°
20°
40°
60°
FRANZ JOSEF LAND
SPITZBERGEN
NOVA ZEMBLA
Kara Sea
Gulf of Obi
Lena Delta
ARCTIC OCEAN
ARCTIC CIRCLE
EUROPE
Petrograd
Baltic Sea
Hamburg
Berlin
Vienna
Paris
Black Sea
Constantinople
Caspian Sea
Aral Sea
ASIA
Okhotsk Sea
Bering Sea
Vladivostok
Japan Sea
Yokohama
Pt. Arthur
Shanghai
Kobe
Suez Canal
Alexandria
Karachi
Calcutta
Bombay
Arabian Sea
Bay of Bengal
Madras
CEYLON
Canton
Hongkong
China Sea
PHILIPPINE IS.
Manila
Guam
Hodeida
Aden
PACIFIC OCEAN
TROPIC OF CANCER
Honolulu
HAWAII
EQUATOR
Singapore
AFRICA
INDIAN OCEAN
MADAGASCAR
TROPIC OF CAPRICORN
Lorenzo Marques
Cape Town
GOOD HOPE
OCEANICA
Pago Pago
FIJI IS.
Tahiti
AUSTRALIA
Sydney
Melbourne
TASMANIA
Wellington
Auckland
NEW ZEALAND
ANTARCTIC OCEAN
Transportation Lines
Route created by construction of Panama Canal
of Largest Commerce
Submarine Cable
Geo. F. Cram, Eng., Chicago.

manner. It is possible for those who are confined within doors to hear sermons, lectures and concerts over the wire. Business, professional and social appointments are quite generally made by telephone, and it has done very much to make country life more agreeable.

The wireless telephone has recently been perfected to a wonderful degree. In October, 1914, messages sent from Arlington, Virginia, were received in Honolulu on the west and in Paris on the east. In both of the receiving stations the voice of the speaker was distinctly heard. More marvelous results may be expected along this line.

The Submarine Cable.—Almost as soon as an event occurs in any part of the world it can be announced in most other parts. This has been made possible through the invention and the use of the submarine cable. In 1839 a wire was laid under the Hoogly River in India, and communication between the opposite banks was established by means of it. Three years later Mr. Morse laid a wire from Castle Garden to Governor's Island, New York. In 1849 a cable was operated between New York City and Jersey City.

Meanwhile the English were active along this line and established a cable between Calais and Dover, a distance of about 25 miles, in 1847. The laying of the first Atlantic cable was commenced ten years later, and on August 13, 1858, the first message was transmitted, which was as follows: "Europe and America are united by telegraph. Glory to God in the highest; on earth peace and good will to men." The cable worked but a short time and in 1865 the *Great Eastern* laid another.

There are today many cables in operation. The longest of these is the Pacific cable from San Francisco to the Philippine Islands. This was laid in 15 months, although it is 8,000 miles long. There were in 1916 about 300,000 miles of ocean cable, most of which was owned by the English.

STUDIES

What was the length of Kit Carson's famous ride? Why does our government handle the mail service? Why is postage higher on first than on second class matter? Why is rapid communication so essential today? What is a "night letter"? Show how the telephone has improved rural conditions. What difficulties are encountered in laying ocean cables? Give some illustrations of the great value of wireless telegraphy and of ocean cables during the World War.

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PART VII

REGIONAL GEOGRAPHY OF THE UNITED STATES

CHAPTER XXXVII

The United States as a Whole

General Statement.—Human response to geographic environment is very marked in the United States. Being situated within the temperate zone, our climatic conditions are favorable to the development of a high civilization. In much of our area the succession of weather changes acts as a tonic, stimulating people both mentally and physically. Our extensive frontage on both the Atlantic and the Pacific Oceans is a great advantage commercially. In spite of rapid consumption and much waste our timber resource is great, and our mineral wealth is enormous. Vast stretches of comparatively level, fertile and well-watered land offer great encouragement to agriculture, and much of the drier and more rugged area is well adapted to stock raising. Until comparatively recent years our country has offered, to all who desired it, free or cheap land. This has been a powerful factor in the development of the United States, for it has drawn to our shores many millions of people from less favored parts of the world.

Coast Line.—On the eastern, the western and a part of our southern boundary we are in contact with the sea. The northern part of both the Atlantic and the Pacific coast line is very irregular, due to subsidence and to glacial action. The southern part is more regular, due to elevation of the continental shelf.

Owing to our favorable position none of the harbors are closed by ice during any part of the winter, as is the case with many of the ports of northern Europe. Our government spends much money in surveying and charting the coast, in improving harbors, and in protecting human life and property by means of lights, buoys, bells, life-saving stations, and the Weather Bureau.

Topography.—Ages ago the waves of the Atlantic Ocean rolled closer to the Appalachian Mountains than they do today. An elevation of the continental shelf produced a plain extending from New Jersey to Mexico. To that part of the area lying north of the Gulf of Mexico has been given the name Atlantic Coastal Plain.

It was indeed fortunate that the first settlers along the Atlantic Coast found a fertile plain instead of a repelling mountain system. The struggle to establish and support themselves was on this account less difficult than it would otherwise have been. Numerous harbors and tidal streams gave easy access to the region. The Appalachian Mountains, the dense forests, and the savage Indians practically confined settlement to the plain for 150 years. This concentration of population gave a solidarity to the colonists which they would not otherwise have possessed.

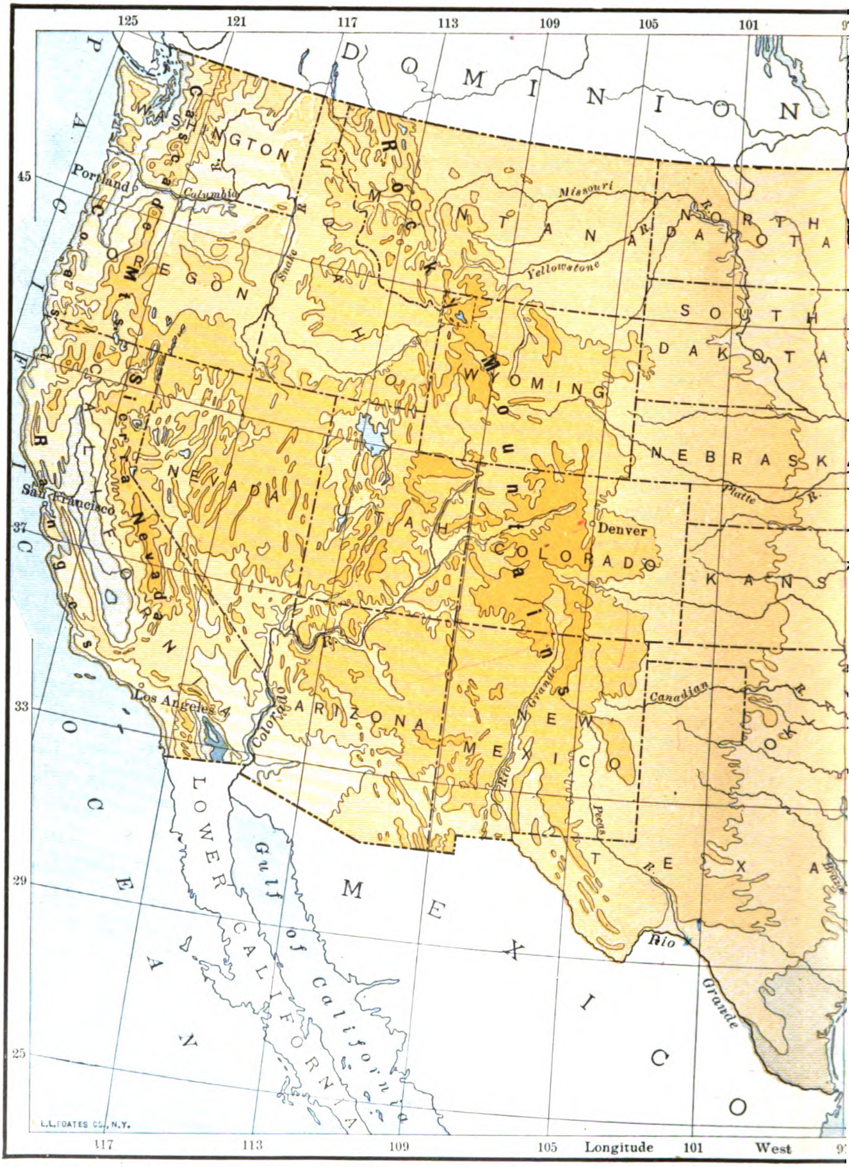
The Gulf Plain is in reality a continuation of the Atlantic Coastal Plain. It extends from Florida to Mexico. There are few good natural harbors. The climate is warm and moist, and the soil for the most part fertile, hence cotton, sugar, rice and fruits are produced in abundance.

West of the Atlantic Coastal Plain is the Piedmont or foothill region which gradually merges with the Appalachian Barrier. The latter consists of mountains, plateaus and valleys, moderate in elevation, ancient and greatly eroded. The mountains gradually increase in altitude from north to south, culminating in North Carolina. These mountains are of great economic importance because of their forest and mineral wealth, and because of the power which their streams furnish.

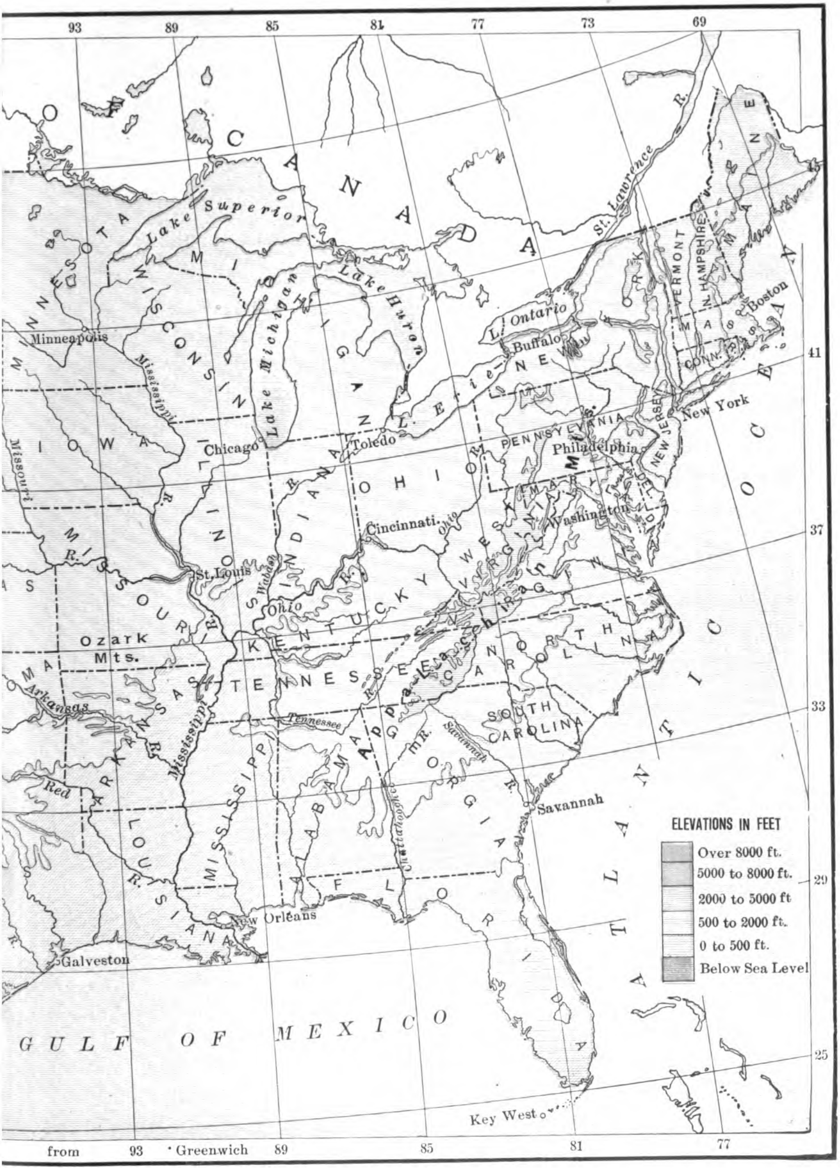
The Central Plain is chiefly drained by the Mississippi and its tributaries. A large part of the area is less than 1,000 feet above sea level. The general level is broken in but few places, the Ozark uplift and the Black Hills being the most lofty elevations. The glacier spread a mantle of drift over most of the northern part, and this, as well as the levelness of the land, has favored agriculture. The slight relief has made the construction of roads comparatively easy.

West of the one hundredth meridian the Central Plain is semi-arid, and, in consequence, is sparsely settled. This region, which is known as the High Plains, terminates at the eastern foothills of the Rocky Mountains. Irrigation, both by artesian and surface waters, has reclaimed large areas formerly valuable only for pasturage. Denver, which belongs to the Rocky Mountain States, but which is in reality situated in the High Plains province, is the only large city in the area.

The Rocky Mountain section consists of many systems, ranges, plateaus and valleys. The great altitude, as well as the great width of these mountains, has caused them to be a very decided obstacle



PHYSICAL MAP OF T



HE UNITED STATES

to the building of roads and to the movement of population and commodities. Increase in population made roads a necessity, and in 1869 the first railroad crossed these mountains. Stock raising and mining are the leading industries. In certain sections the scenery attracts large numbers of people every summer.

Enclosed by the Rocky Mountains on the east and the Sierra Nevada and Cascade Mountains on the west, is an extensive plateau consisting of three chief divisions. The most northerly division is called the Columbia Plateau. Over much of this area vast floods of lava have been poured. The Snake River has carved its canyon in this lava to a depth of nearly a mile in one place.

The middle section of the plateau is called the Great Basin. This area has numerous mountain ranges trending in a general north-south direction. They are block mountains which in most cases show by their form, by hot springs and by frequent earthquake shocks the evidences of youth. Precipitation is deficient in the Great Basin, and except where irrigation is practiced population is very sparse. The drainage does not reach the sea, hence is said to be *continental.*

The Colorado Plateau is the most southerly of the three divisions. Parts of it reach the altitude of 8,000 feet above the sea, and some of the mountains rise several thousand feet higher. The valleys are of the canyon type, offering little encouragement to settlement and being an obstacle to transportation and travel.

The eastern boundary of the Pacific Slope is formed by the crest line of the Sierra Nevada and the Cascade Mountains. These mountains are young geologically, and many of the peaks of the latter are volcanic. The most lofty parts of the mountains rise above the snow line, and owing to their altitude most of the passes are unfavorable to the construction of railroads.

Between the Sierra Nevada and the Cascade on the east and the Coast Ranges on the west is the great valley of California, and the much smaller but very fertile valley of the Willamette.

The Coast Ranges are nowhere very lofty, but they are quite rugged and greatly restrict settlement. In the north they are well watered and covered by forests, but in the south, where precipitation is light, forest growth is much less luxuriant.

Hydrography.—The waterways and their valleys have played an important part in the development of the United States. The Altantic Slope has many streams the lower courses of which are navigable by vessels drawing but a few feet of water. The Hudson is of great commercial importance. The Ohio is navigable to Pittsburgh by vessels of light draft and the deepening of the channel is contemplated. The Mississippi offers a great mileage of navigable waters, and it also will be deepened. The surface features of the country are such that it has been feasible to dig canals in many places. Although a number of canals have been abandoned, some 2,000 miles of canals are now in operation. The Great Lakes are of tremendous value in the transportation of commodities. Few streams in the western part of our country are of value from the standpoint of navigation. This is in part due to lack of depth and in part to gradient. The Columbia is the most navigable of our western rivers.

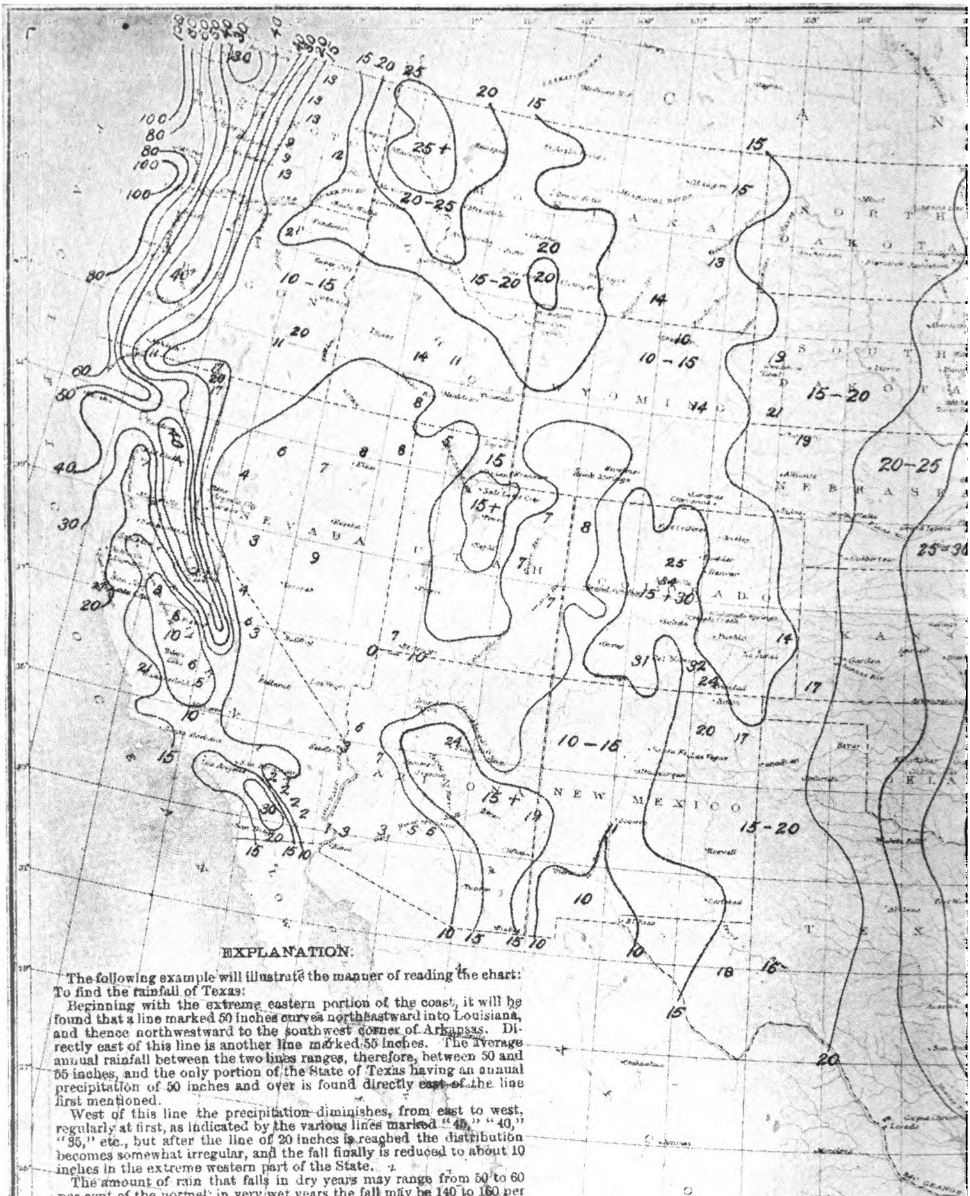
The rivers of the United States furnish much power, only a part of which has as yet been developed. This is especially true of the western part of the country. The recently constructed dam at Keokuk, Iowa, is an illustration of what may be done. Here some 300,000 horse-power is developed. The Pacific Slope has a tremendous amount of water power owing to the distance which the streams fall. California alone is estimated to have 6,000,000 horse-power. This is especially important as the state has practically no coal.

Climate.—The United States extends from the twenty-fifth to the forty-ninth parallels of north latitude. As a result there is much variation between the climatic conditions in the southern and in the northern parts of the country, with a corresponding variation in products. Because of the vast area of the country the climate in the interior is continental. Owing to the influence of the ocean, the climate of the west coast is very equable.

The relief being great, the altitude varying from 265 feet below sea level to 15,000 feet above, altitude plays an important part in determining climate in the United States.

All of the United States east of the one hundredth meridian receives sufficient precipitation to support agriculture. Locally west of this meridian, especially along the northwest coast, the precipitation is heavy, but there are extensive areas where arid conditions prevail.

In the northern part of the country the winters are long and severe and blizzards occasionally obstruct transportation. In the southern part snow and frost seldom occur. The central part of the Mississippi valley, especially during the summer months, is visited at intervals by destructive tornadoes. On the Pacific Slope there are but two



MAP SHOWING PRECIPITAT
(Courtesy United States Departm

ION IN THE UNITED STATES

nt of Agriculture, Weather Bureau.)

seasons, the wet or winter season, and the dry or summer season. Elsewhere there are four rather clearly defined seasons.

Forests.—Originally our country had a much more extensive forest area than it now has. About 18 per cent. of our total area is classed as forest, a part of which is owned by the government. Fig. 115 shows the four chief areas in the United States. Timber is one of the most valuable resources which a country can have because of the many important uses to which forest products are put. Lumber was one of our first exports, and is today an export. Much thought is now being given to forest conservation, and trees are being planted by individuals as well as by the government.

Mineral Wealth.—Our country is exceedingly rich in minerals, being the greatest producer of mineral wealth in the world. The total value of our output of minerals is about $2,500,000,000 annually. We have tremendous quantities of coal, iron, petroleum, copper, lead, zinc, gold, silver, mercury, salt, natural gas, building stones, clay and mineral waters.

Investigation has shown that we have a larger reserve of the minerals which are essential to great industrial development than has any other nation. These conditions give us a great advantage from the standpoint of manufacturing. It is highly probable that the nations of western Europe will in the future look to this country for a large part of their supplies of coal.

Soil.—A fertile soil is an asset of priceless value. Although there are in the aggregate considerable areas of land within our borders that are non-productive because of alkali, most of our arid lands need but the application of water to render them highly productive.

In the arid and semi-arid West the soil is deficient in humus, but owing to light rainfall the soluble elements of the soil have not been leached out as they have been in more humid regions. In most of the Mississippi basin north of the fortieth parallel glaciers have been of great benefit in preparing the soil for agriculture.

A soil survey is being carried on by the government, the results of which enable the prospective settler to determine whether or not he desires to locate in a given region. By taking advantage of the facts which the survey presents, farmers know what crops are best adapted to their soils and the special treatment which each soil requires.

About 40 per cent. of the total area of the United States is classed as productive, but only about 15 per cent. is under cultivation. For the five-year period ending with 1915 the average annual value of all crops grown in our country was about $6,000,000,000. In 1917 the value was $13,600,000,000. These figures are too large to be comprehended, but they serve to show the economic importance of the soil. Through the reclamation of both swamp and arid lands, the area devoted to agriculture is yearly increased.

Manufacturing and Commerce.—Although our country is so young, manufacturing has assumed much importance. This is because of our favorable climate, fertile soil, immense output of raw materials from the farm, forest and mine, our widely distributed water power and the general intelligence of our people. Where natural conditions are the most favorable, manufacturing has made the greatest progress. Industry is highly developed in the northeastern part of our country. The states bordering upon the Great Lakes have the advantage of cheap transportation.

From the standpoint of the value of the products the leading manufactures rank as follows: Meat, foundry and machine shop articles, lumber, the output of steel and rolling mills, flour, books and other printed matter, cotton goods, clothing, boots and shoes, woolen goods.

In the value of products the five leading states were, in 1914, New York, Pennsylvania, Illinois, Ohio and Massachusetts. The order has been practically the same for many years. Cheap fuel, cheap transportation for raw and finished products, large population and ready markets are the factors which explain this. Of the total power used in the United States for manufacturing in 1914 about 10 per cent. was produced by falling water. According to Leighton, the available water power in the United States is sufficient to do all of our manufacturing. "There is more than enough water power in the United States to fulfill every want that may reasonably be expected to arise in many generations."[1]

Our domestic commerce is more important than our foreign commerce. Our exports are chiefly raw products which go to more densely populated countries. We import, in large quantities, sugar, coffee, tea, cocoa, raw silk, rubber, tropical fruits, hides, skins and dyes.

Roads.—The mileage of both wagon and railroads is rapidly increasing in the United States. This and improvements in the roads

[1] Leighton: "Annals of the American Academy of Political and Social Science," vol. xxxiii, p. 546.

and rolling stock are of great importance in carrying on our domestic commerce. In 1917 the total mileage of wagon roads in the United States was about 2,400,000, and in the same year there was expended on these roads about $200,000,000.

The improvement of roads has been of great benefit to rural life. Commodities can be more cheaply marketed. It means more accessible and better schools, and easier means of communication for all purposes.

In 1917 there were in our country more than 260,000 miles of railway, or about 8 miles to each 100 square miles of territory, and about 26 miles to each 10,000 inhabitants.

Population.—The population of the United States has increased enormously since the first census was taken in 1790. The rapid increase in population, as well as its cosmopolitan character, are due to the relatively cheap land, the vast natural resources, the field for all kinds of labor at good wages, the freedom from military service, and other forms of civil liberty.

TABLE 45.

GROWTH OF POPULATION IN THE UNITED STATES.[2]

Census Year	Population of Continental U. S.	Gain Per cent.	Population per square mile
1790	3,929,214	...	4.5
1800	5,308,483	35.1	6.1
1810	7,239,881	36.4	4.3
1820	9,638,453	33.1	5.5
1830	12,866,020	33.5	7.3
1840	17,069,453	32.7	9.7
1850	23,191,876	35.9	7.9
1860	31,443,321	35.6	10.6
1870	38,558,371	22.6	13.0
1880	50,155,783	30.1	16.9
1890	62,947,714	25.5	21.2
1900	75,994,575	20.7	25.6
1910	91,972,266	21.0	30.9
1920 (Preliminary)	105,683,108	14.9	34.8

The United States has by no means reached the limit of its power to support a population and its density of population is far below that of many other countries, as is shown by Table 46.

[2] Census Report, 1910, vol. i, pp. 24 and 41.

TABLE 46.

AREA AND POPULATION OF CERTAIN COUNTRIES.[3]

Country	Area in square miles	Population	Persons square mile
United States	3,026,789	105,683,108 (1920)	34.8
United Kingdom	121,316	46,089,000 (1916)	379.5
Holland	12,648	6,583,000 (1915)	498.7
Belgium	11,373	7,658,000 (1913)	673.
France	207,054.	39,700,000 (1916)	191.6
Germany	208,780	67,810,000 (1913)	324.7
Italy	110,550	36,546,000 (1916)	330.2
Russian Empire	8,647,657	178,905,000 (1915)	21.5

Our density of population is of course much higher in the eastern and central parts of our country than it is in the western part. In 1920 Rhode Island ranked first, having 566.4 persons per square mile. Nevada was at the foot of the list, having a density of but .7 person per square mile. Not a state west of the Mississippi River had a density as high as 50 per square mile, and but 10 states in the Union had densities of 100 or more.

Our Census Reports show that in 1910 there were in the United States 32,243,442 persons classed as "foreign white stock." This includes people who were born in foreign countries, and children whose parents were not born in this country. The chief sources of our foreign-born population, according to the census of 1910, are shown below.

TABLE 47.

SOURCES OF OUR FOREIGN-BORN POPULATION IN 1910.[4]

Country	Number of persons
Germany	8,282,618
Ireland	4,504,460
Canada	2,754,615
Russia	2,541,649
England	2,322,442
Italy	2,098,360
Austria	2,001,559
Sweden	1,364,215
Norway	979,099
Hungary	700,227
Scotland	659,663
Denmark	400,064
Mexico	382,002
Switzerland	301,650

[3] Statistical Abstract of the United States, 1912, pp. 800, 801.

[4] Census Reports, 1910, vol. i, p. 875.

POLITICAL MAP OF

HE UNITED STATES

During recent years there has been a great increase in the number of immigrants from the southern part of Europe, Italy and Russia particularly. The Italians and the Russians usually locate in the cities. The Scandinavians, in large numbers, settle in the northwestern part of the United States and engage in lumbering and wheat growing.

It is true that our country has furnished homes to millions of people who were not content with conditions in their home lands. It is equally true that our country owes very much to these people.

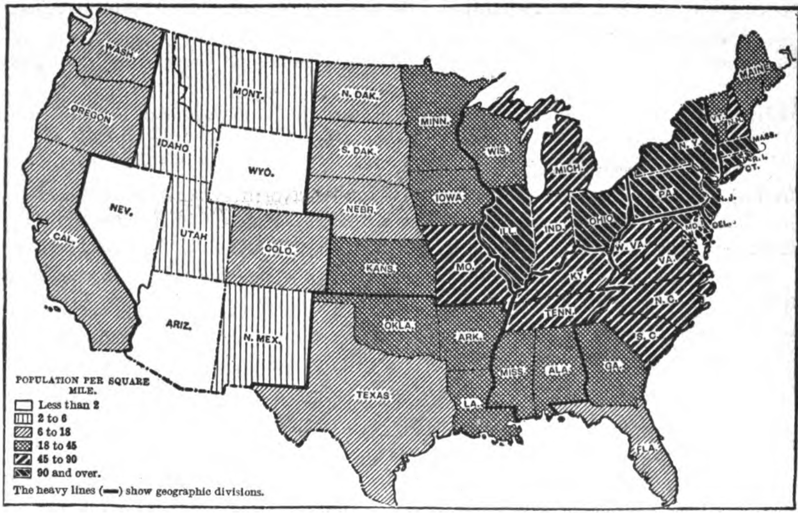


FIG. 151.—Density of population in the United States. 1910 U. S. Census Report.

NOTE.—Except as applied to Arizona, California, Washington, Wisconsin, Alabama and Georgia, the above map correctly represents the density of population according to the census of 1920.

They have helped to clear the land and establish farms, build roads, operate mines, develop cities, maintain schools and churches, and govern the nation. In other words, the development of the resources of the United States and the growth of its human institutions are entirely due to the work of men and women who at the most are but a few generations removed from an ancestry whose home was in Europe.

STUDIES

Why are there so many more lighthouses and life-saving stations on our eastern than our western coast? Where do valleys and passes exert the greatest influence upon our transcontinental railroads? Upon a base map of the United States, indicate the head of navigation of each important river. Which of the states have no navigable rivers? Compare the average date of the first killing frost in St. Louis with the date of the same event in St. Paul. Account for the difference. Compare the value of the minerals produced yearly in the United States with the average annual value of our crops. What restrictions does our government place upon immigration? Make a study of one or more ways in which our government has encouraged industry.

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CHAPTER XXXVIII

THE NEW ENGLAND PROVINCE

General Statement.—The total area of the New England states is equal to only about two-thirds that of the state of Colorado, yet in 1920 the population of the former was 7,400,856, while that of the latter was but 939,376. In the same year New England had ten cities in each of which the population was more than 100,000, although Colorado had but one city belonging to this class. New England is essentially industrial. In 1910 her urban population was 83 per cent. of her total population. In the same year 50 per cent. of the total population of Colorado was classed as urban.

Topography.—New England is largely a highland region, nearly all of which slopes to the Atlantic Ocean. Although the mountains are not lofty, there is considerable relief. Mt. Washington, altitude 6,293 feet, is the highest point in the northern Appalachian Mountains, and Mt. Katahdin, altitude 5,273 feet, is the most lofty peak in Maine. The Green Mountains and the Berkshire Hills on the west and the White Mountains on the east send water to the Connecticut Basin, the largest of the New England basins.

Geologically New England is one of the oldest parts of North America. It was once a region of lofty mountains, but many centuries of erosion reduced them nearly to sea level. The rocks are largely crystalline, schists and gneisses being widely distributed. This means that these rocks were originally at great depths, for only under great pressure are such rocks formed. The monadnocks which here and there rise above a remarkable even skyline are the remnants of the more resistant peaks.

When this region had reached the stage of maturity or old age it was broadly uplifted. Only on this theory can the youthful valleys be accounted for. The elevation rejuvenated the streams, which, as a result, have so dissected the old lands as to form the relatively deep and steep-sided valleys which are characteristic of youth.

The ice invasion, which occurred later than the elevation, was a powerful factor in shaping the topography. The ice covered practically the entire area. Countless hills which diversify the landscape are of glacial origin and most of the lakes and falls are the result of ice action.

Comparatively recently a depression took place. This admitted the sea to the lower parts of the land, drowning the seaward portions of the river basins and converting many hills and ridges into islands and peninsulas.

Where the rocks are not very resistant, lowlands have developed. Weak sandstones and shales are found in the lower Connecticut valley nearly to the northern border of Massachusetts. Here erosion has developed a broad valley, while on the more resistant rocks farther north the valley is narrower and more rugged. Weak rocks also exist in the lowland area tributary to Narragansett Bay and in the Boston Basin which is adjacent to Boston Bay.

The most rugged portions of New England are the most sparsely populated. The Boston Basin contained in 1920 about one-half of the population of New England. In the same year the density of population in Rhode Island was 566 per square mile, and in Vermont but 37 per square mile. The surface features have discouraged agriculture on a large scale.

Transportation, both by rivers and by roads, is definitely related to the topography. In general the rivers are not navigable, but the valleys have guided land routes. The valley of the Connecticut is an important route of travel, and the tributary valleys of the Deerfield and Westfield lead to the Berkshire Barrier and to New York State. To secure cheaper transportation between New England and the West, and especially to benefit Boston, the Hoosac Tunnel, nearly five miles in length, was constructed through the Berkshire Hills. The tunnel has an elevation of 2,300 feet and is used by the Fitchburg Railroad, which enters the valley of Deerfield River at Greenfield. This route leads to the Mohawk depression and to the interior of our country. The Boston and Albany Railroad enters the valley of the Westfield River at Springfield, Massachusetts. The road follows the valley for some distance and crosses the Berkshire Hills, reaching the Hudson valley at Albany.

Influence of the Glaciers.—That glaciers once covered all of New England is shown by the drift and by the polished and striated rock. Lake basins were enlarged and others scooped out of solid rocks. Streams were blocked by the drift, thus giving rise to numerous lakes and falls. The water power thus created led to the establishment of many towns and to the development of manufacturing.

The ice swept much of the soil from the steeper slopes. Some of this was carried to the sea and some left upon the lower lands. Boulders in countless numbers were scattered over the surface of the country, greatly to the disadvantage of agriculture. It has been estimated that upon the average it requires the labor of one man for one month to entirely remove the boulders from an acre of land. The action of the glaciers reduced the angular features of the topography and produced a subdued effect. Whittier's expression, "The hills roll wave-like inland," has much of truth in it.

Hydrography.—Owing to the relief of the land and the influence of the ice, the rivers are of little value for navigation, but are of great value from the standpoint of power. The Penobscot, which is about 200 miles in length, rises at an altitude of about 2,000 feet. It is navigable to Bangor, 60 miles from the sea. The Kennebec, which has its source in Moosehead Lake at an altitude of 1,026 feet, is about 150 miles in length. Augusta, 44 miles from the sea, is at the head of navigation, there being 10 feet of water at this point. The average fall of the river from the lake to tidewater is 8.5 feet per mile. The upper part of the basin is well forested, thus helping to regulate the flow of the water. There are many falls in the river and power has been developed at several points. At Augusta a dam gives a head of 17 feet of water. Here are cotton mills and a light plant. The Kennebec River is one of the best power streams in the United States and is open 8 months in the year. Between Augusta and Richmond much ice is cut on the Kennebec River, and is shipped to cities in the South.

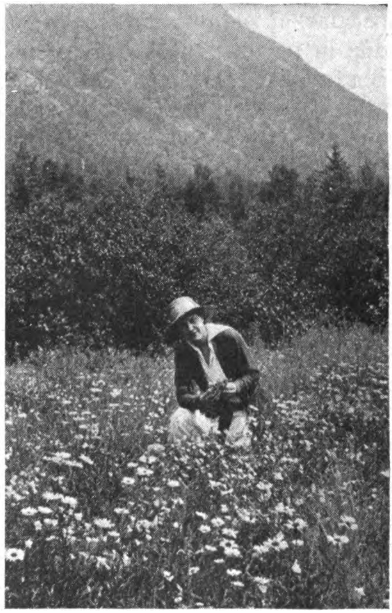


FIG. 152.—Picking wild flowers in the White Mountains.

The Androscoggin is navigable to Lewiston, about 30 miles inland, where considerable power is developed. At Rumford Falls the river drops 177 feet in one mile, and its power is used in the manufacture of pulp and paper.

Saco and Biddeford, but 5 miles from the coast, are at the head of navigation on the Saco River. Here there are cotton mills. Haverhill, at the head of navigation on the Merrimac, is 17 miles from the sea. The river is famous for the power which it furnishes. Haverhill, Lawrence, Lowell, Nashua and Manchester owe their early importance as cotton and woolen manufacturing centers to water power.

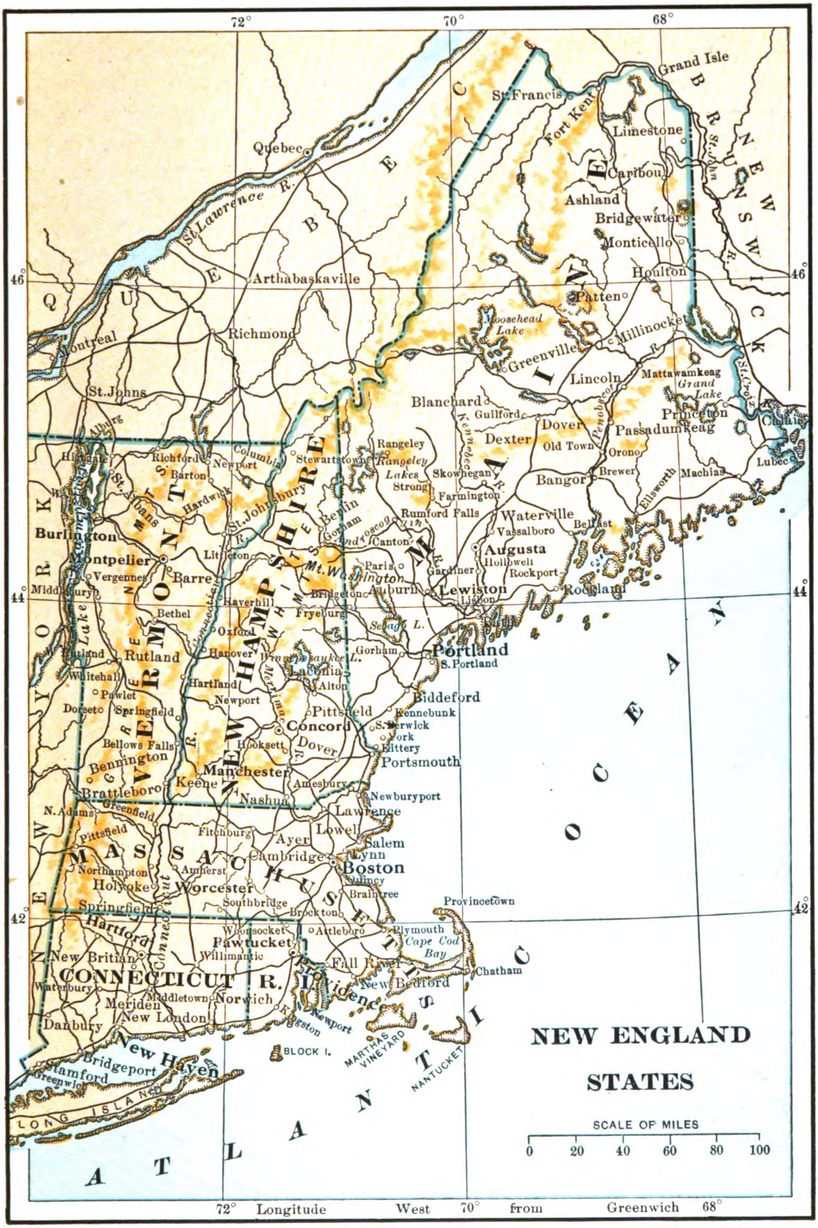
The Connecticut is the largest of the New England Rivers. In its course of 345 miles from the Connecticut Lakes it falls 1,900 feet. The upper part of the basin is rugged and narrow, largely because of the resistant rocks. In its lower part the valley is wider, due in part to the softer rocks, and here agriculture is important. Boats ascend the river to Hartford, a distance of 50 miles. At Holyoke a dam was constructed in 1849. Here the river falls 60 feet in one and one-half miles, and much power is used in the manufacture of paper. Power is developed also at Wilders, Bellows Falls and Turners Falls.

The large area covered by forests, as well as the numerous lakes and ponds, is an important factor in regulating the flow of water in the streams, thus increasing their value as power producers. Maine has more than 1,500 lakes, most of which are of course quite small. The largest lake entirely within New England is Moosehead Lake. This has long been used as a reservoir in which to store water for log driving and for the development of power.

Although much water power is still used directly, electrical energy developed from falling water is much more important today. In 1870 streams furnished 70 per cent. of the power used in New England for manufacturing. In 1900 the percentage had fallen to 35, and in 1910 to 27.

Climate.—New England is about 500 miles south of the southern shore of Great Britain, yet its climate is colder in winter and warmer in summer than that of London. The January isotherm of 50° F. touches the southern coast of England, but the mean average temperature of Boston during the month of January is 27° F. The July isotherm of 63° F. passes close to London, while that of 72° F. is drawn through Boston.

In other words, New England has a variable or continental climate due to the fact that the prevailing winds blow across the continent before they reach this area. These winds carry to New England the high summer and the low winter temperatures of the land to the westward. In New England, especially upon the highlands, snow remains upon the ground for several months each year, and the growing season is much shorter than it is in corresponding latitudes upon the Pacific Coast of the United States. In the lower part of



MAP OF NEW ENGLAND

the Connecticut valley spring comes about one month earlier than it does in the northern part.

The precipitation in New England is everywhere abundant and evaporation is not rapid. In most of the area the annual precipitation varies from 40 to 50 inches and is quite uniformly distributed throughout the four seasons.

Forests.—Originally nearly all of New England was forested, white pine, spruce and hemlock predominating. There was a market for lumber in Europe and the timber was rapidly cut. So rapidly

FIG. 153.—In New England.

was the land cleared that by 1870 New England had lost her supremacy as a lumber producer. Naturally the forest areas nearest the coast were the ones first cleared of timber. Maine has much timber left, and lumber is second in value among her products.

The portion of the St. John Basin which is in Maine is well forested. The same is true of the St. Croix and the northern parts of the basins of the Penobscot, Kennebec and Androscoggin. In the northern part of the Kennebec Basin the population is chiefly lumbermen. Much timber yet remains in the Connecticut basin. Associated with lumbering are the industries of barrel and box making, the manufacture of paper pulp and paper, of furniture, vehicles, spools, toys and other articles.

Influence of the Ocean.—The ocean has exerted a definite influence in shaping the geography of New England. The subsidence

25

produced an extensive coast line which reduces the cost of transporting commodities to and from the interior. Maine has some 2,000 miles of fiorded coast line. Along the irregular well-settled coast of New England much protection is needed. Hence the government spends large sums of money in maintaining lights, buoys, bells and life-saving stations.

Cape Cod has long been an obstacle to coastwise commerce because it has increased the distance between northern and southern ports, and because of the large annual loss of property and life off its coast. More than 200 years ago it was recognized that the cutting of a canal across the base of the cape would be a great saving to shipping. Not until July 29, 1914, did the canal become a reality, however.

The Cape Cod Canal, which cost $12,000,000, is the result of private enterprise. It is about 8 miles long, and connects Cape Cod on the north with Buzzards Bay on the south. A depression in a moraine, which is followed by the Boston-Providence Railroad, afforded an easy route.

An immense tonnage passes through the canal. Coal *for* New England and lumber *from* New England are the most important commodities. The canal reduces the distance between northern and southern ports by 60 to 70 miles, and consequently lessens the cost of shipment. As the danger from storms is decreased, this results in a direct saving, and it also lowers the insurance rates. Throughout its entire length the canal is illuminated just as is a city street.

The excellent fishing off shore, as well as the numerous bays affording anchorage, led to the development of fishing. Although Boston and Providence are noted centers of the fishing industry, Gloucester, which is protected by the granite of Cape Ann, is the most important in all New England.

Much fishing is done close to shore, but many crews go to the Grand Banks. On these longer trips the fishermen are gone for weeks at a time. The prevalence of fogs on the Grand Banks makes the fishing industry rather hazardous there. Contact with the sea developed seamanship, and in early days our merchant marine was largely recruited from these shores.

Wave erosion has developed many interesting shore features. In speaking of this work Emerson makes the ocean say: "I drive my wedges home, and carve the coastwise mountains into caves." Owing to the large urban population, the numerous bays, the picturesque scenery and the cool summer climate, there are many resorts along the Maine coast.

Agriculture.—Surface, soil and climate are unfavorable to agriculture in New England, but dairying is an important industry. The slopes afford much good pasturage and there is a large area devoted to the production of hay and forage. There are many cities in New England, therefore, where the dairying industry is a response to human as well as physical conditions. Many people are engaged in truck farming because of the local demand for vegetables.

FIG. 154.—Preparing dry fish in New England.

Potatoes are grown extensively in Aroostook County, Maine. In 1918 this limited area produced about 4 per cent. of the total potato crop of the United States. Sumatra tobacco is grown in the Connecticut valley and cranberries on Cape Cod.

Mineral Wealth.—There is little mineral wealth in New England aside from building stones, of which there is an abundant supply. Vermont ranks first among the states of the Union in point of total value of granite produced. Large quantities of granite are quarried in Massachusetts, Maine and New Hampshire. Measured in terms of value, New England produces nearly one-half of the granite quarried in the United States. Vermont produces more marble than does any other state in the Union. There are extensive quarries near Proctor and Montpelier. Considerable sandstone and slate also are quarried in New England. In Massachusetts clay deposits are worked.

Industries.—It was but natural, since topography, soil and climate and a dense forest cover were all unfavorable to agriculture, and since there was an abundance of water power, excellent harbors and an oversea market, that the people of New England should have turned to industry and commerce.

The industry of lumbering has already been sufficiently emphasized. Fishing developed at an early day and is yet very important. New England is reasonably close to food fishing grounds; she has good harbors; she has the material from which to construct the vessels, and there has always been a good market both at home and abroad. Another decided advantage is found in the fact that a large part of the population is situated near the seacoast. "Colonial records show that during the century beginning with 1650 the prosperity of the northern settlements was closely connected with deep-sea fishing."[1]

Gloucester and Boston are today the great fishing centers. Gloucester owed its early importance to the fact that it had the best port on Cape Ann and that it was the first of the ports to secure railroad connection with Boston.

Of raw material for export New England produces little but lumber, but the cotton and the sugar of the South, the wool and leather of the West, the iron of Pennsylvania, the rubber of the Amazon basin and the silk of Italy and France can, owing to water power, nearness to coal, an abundance of capital, skilled labor and good markets, be converted in New England's mills into manufactured articles at a profit.

New England manufactures everything from pins to locomotives. More than one-half of the cotton, woolen, leather and rubber goods made in the United States are manufactured in New England. Cotton goods are turned out in large quantities at Fall River, Lowell, New Bedford and Manchester, and woolen goods at Lawrence, Pawtucket, Woonsocket and Providence. Haverhill, Lynn and Brockton are noted shoe towns. Firearms are made at Springfield, Massachusetts. Waltham manufactures watches, and Holyoke paper. At Providence there are locomotive works. Worcester manufactures wire, and Willimantic thread. Dorchester is the home of Baker's chocolate, and at Quincy Point shipbuilding is carried on. This is suggestive of the importance of manufacturing in the New England states.

The development of manufacturing has led to a relatively dense population and to the growth of cities. For many years, however,

[1] Moore, J. R. H.: "Industrial History of the American People," pp. 21, 22.

the increase in population has not been so rapid as that of some other areas. In 1790 the population of New England was 1,009,408. One hundred years later it was 4,700,749, and in 1910 it was 6,552,681. The increase during the decade between 1900 and 1910 was 17 per cent. During the same period the population of the United States increased 21 per cent., and that of the Pacific Coast States 73 per cent.

TABLE 47.

DENSITY OF POPULATION IN THE NEW ENGLAND STATES IN 1910.

Area	Density
Maine	24
New Hampshire	47
Vermont	37
Massachusetts	466
Rhode Island	566
Connecticut	276
United States	34

This shows that the three states in which manufacturing is most important, and which have the largest area of relatively level land, have the most dense population. The large forest area in Maine and the lack of coast line in the case of Vermont are factors that reduce the population.

There is an interesting relationship between manufacturing and the number of foreign-born persons in the several states. In 1910 the percentage of the foreign born was, in Maine, 15; in New Hampshire, 22; in Vermont, 14; in Massachusetts, 31; in Rhode Island, 33; and in Connecticut, 29.

In some sections of rural New England the population has decreased. This is in part because the West and Middle West have offered much greater opportunities to the farmer, and in part because of the attractions which city life has for most people.

In 1920 there were in the United States 68 cities each of which has a population of 100,000 or more. Ten of these cities are located in New England and seven of them are in Massachusetts.

Boston, the metropolis of New England, was settled in 1630 and received its name from a town in Lincolnshire, England. Boston Peninsula is connected with the mainland by a narrow isthmus. In early days this was flooded at high tide when a strong wind blew from the sea. This effect of the tide was an advantage from the standpoint of defense, and was a factor leading to the location of Boston. A supply of good drinking water was another. Several natural conditions have contributed to the growth of the city. It has a large and well protected harbor with deep water. The harbor is open all of the year, and tributary to it is the largest lowland in the state, Boston Basin. Boston has become a great distributing center and is therefore an important railroad and steamship terminus.

Boston is a little nearer to Liverpool than is New York. It is also the eastern terminus of the most direct route between Chicago

FIG. 155.—Collecting maple sap in New England.

and the Atlantic seaboard. The Berkshire Barrier prevented Boston from successfully competing with New York City in the matter of transportation between the coast and the interior. The opening of the Hoosac Tunnel did much to equalize conditions, but Boston cannot hope to rival New York City as a seaport and a center of population. The Boston and Maine Railroad connects Boston with Montreal.

Boston is today our second seaport in importance. It is a receiving and distributing center for a district in which there are many cities and towns which are important industrially. Boston is a noted money center, a great wool market, a sugar refining city, an important market for hides, and a fishing and a publishing center.

Considerable of our early history was enacted in Boston or in the immediate vicinity, and this is one of the reasons why so much interest centers in the region about Boston Bay. Art, literature and all phases of human achievement have een and are so prominent that the city has long been called "the Hub."

Providence, Rhode Island, owes its foundation to the principle that the government has no right to interfere with a man's religious views. In 1636 this principle was recognized by few, and for boldly advocating it Roger Williams was banished from Massachusetts. In the same year he established a colony where is now located the city of Providence.

The capital of our smallest state is situated upon both banks of the Providence River at the head of Narragansett Bay, about 35 miles from the sea. The city, which has a south exposure, is sheltered by hills on the north. As a result, the temperature of Providence is slightly higher than is that of Boston, which is only about 40 miles north.

In early days there was much timber in southern New England, and Providence was an exporter of lumber. Owing to the favorable situation of the city, the large bay and the existence of water power close at hand, both commerce and industry developed. About 1840 the foreign commerce of Providence began to decline because the depth of the water in the bay was not sufficient to accommodate the largest ocean liners. The channel has recently been deepened considerably, thus increasing the commerce of the city.

As an industrial center Providence is very important. Worsted goods are made in great quantities, and there are large cotton mills. For more than a century the manufacture of jewelry has been a leading industry, and the annual output is worth several millions of dollars. Gold and silver ware, iron and steel products, and locomotives are other things manufactured extensively. The water supply of the city comes from the Pawtucket River, which has its source in the hills to the north and west. In 1920 Providence had a population of about 250,000.

STUDIES

Why has New England such a large population? What evidence that the coast line of New England has been depressed during recent geological times? Discuss the ways in which the action of the glaciers benefited New England. How is the geology of New England related to economic conditions? Where are the conditions unfavorable for agriculture? Where does New England get her coal? Why has population increased more slowly during recent years in New England than on the Pacific Coast? How does the Cape Cod Canal benefit New England? What principle is brought out by a comparison of the climate of New England with that of the Pacific Coast of the United States in the same latitude?

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CHAPTER XXXIX

New York State

General Statement.—New York rather than Pennsylvania is the Keystone State. It has exerted a greater influence upon the development of our country than has any other state, and this influence is the result of geographic conditions. One of the few natural routes into the interior of the United States passes across New York, and beside the seaward entrance to this route stands New York City. Through this gateway there passed, in 1910, thirty-seven per cent. of our entire exports and fifty-eight per cent. of our total imports. Practically all of our immigrants, about 1,000,000 yearly previous to 1915, land in New York City. New York State leads the Union in population, wealth, value of manufactures and bank clearings.

Topography.—The map shows that in general the eastern and southern sections of New York are hilly or mountainous and the central and western sections are lowland. The east and the west are connected by the Hudson-Mohawk depression.

The Adirondack Mountains, in the northeastern section, have resulted from the dissection of an ancient plateau. The highest peak is Mt. Marcy, 5,344 feet in altitude. The Adirondack province is largely made up of crystalline rocks of ancient origin. Surrounding the highlands is a lowland belt. Owing to the altitude, the winters are long and severe. The ruggedness of the surface is unfavorable to agriculture, but a thin soil, the result of the influence of the glacier, is the greatest obstacle. Lack of markets near by and of easy means of transportation account for the fact that much timber remains in the Adirondack region. Much water power has been developed and is used in the surrounding lowlands in the manufacture of wood pulp. There is some iron in the region, and there are smelters at Fort Henry and Crown Point. The Adirondack province is one of sparse population.

In the southeastern part of the state is the Catskill province. The mountains were greatly eroded and then uplifted. The uplift gave the streams renewed power which resulted in the dissection of the region. Unlike the Adirondacks, the Catskills are composed of horizontal beds of limestone, sandstone and shale. Although less lofty than the Adirondacks (3,500-4,200 feet), the region is sufficiently rugged to have greatly restricted settlement. This condition of the surface has its advantage, however, for the beauty of the scenery as well as a large state park attract many summer visitors.

Lumbering is carried on to some extent, and the sheep and dairying industries are important. The population is sparse. The Catskill province is a drainage center from which the Hudson, the Delaware and the Susquehanna draw water. The city of New York has expended a vast sum of money in order to secure a water supply in the Catskill Mountains.

The Lake plains are bounded on the south by the Niagara Escarpment, which extends from Rochester westward into Canada. The Niagara River drops over this escarpment at Niagara Falls. As the soils are fertile and the climate is modified by the lakes, the province is well adapted to agriculture. The soil is largely glacial till produced by the grinding up of the local limestone and shale.

The Mohawk-Hudson depression is one of the most strongly marked physiographic provinces of the state. The work of the glacier united an east-sloping and a west-sloping valley, thus forming the present Mohawk valley. The rocks in the Mohawk depression are largely shales of slight resistance, hence a broad valley has developed.

The Mohawk-Hudson depression forms the most important route of travel in the state, and one of the most important in the world. The New York Central and Hudson River Railroad follows this depression. The Mohawk Valley varies from twelve to twenty miles in width and is about ninety miles long.

Hydrography.—The Hudson is the most important river in New York, and commercially it is one of the most valuable in the United States. From its source in the Adirondacks the river has a length of some 300 miles. The drowning of the river valley produced deep water as far north as Albany, to which point the tide ascends. Through boats run from New York City to Albany.

Borings made in the bed of the Hudson show that east and a little south of the Catskill Mountains it is from 750 to 900 feet to bed rock. In other words, there is here a sediment-filled valley formerly nearly 1,000 feet deep. The sediments extend below present sea level. Soundings carried on off the mouth of the river have revealed a submarine canyon in one place 3,800 feet in depth. As a valley could not be eroded in this depth of water, we have here a proof of the subsidence of the region. The submarine valley of the Hudson has been traced about 120 miles.

At many places along the upper Hudson power has been developed. Among these may be mentioned Glens Falls and Cohoes at the junction of the Hudson and the Mohawk. The Mohawk has developed many falls which have led to the location of towns and the growth of industries.

A part of the drainage of the state is carried southward by the

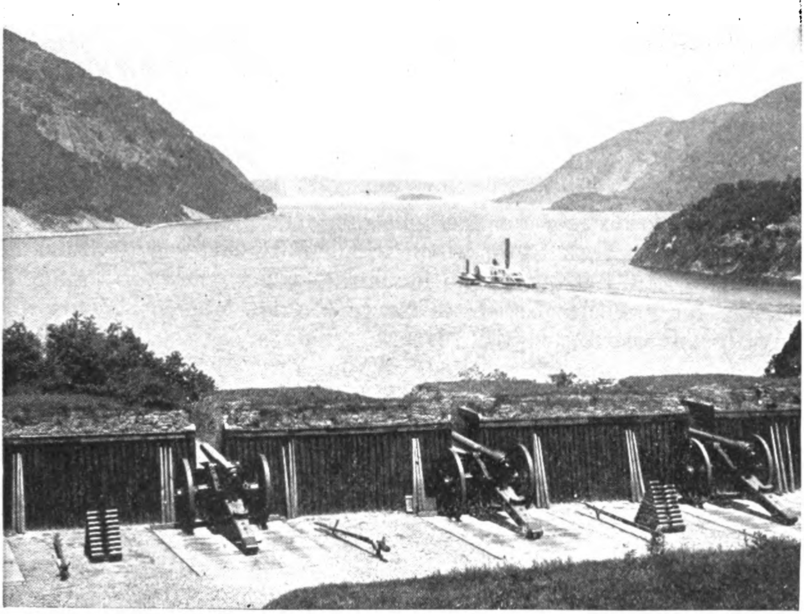


Fig. 156.—The Hudson River near West Point.

Susquehanna and the Allegheny. Owing partly to the proximity of the Pennsylvania coal fields, Binghampton, Elmira and other towns of importance have developed in the Susquehanna Basin.

The Genesee flows entirely across the state. At Rochester there is a fall which in early days was used to operate grist mills. It now gives rise to various lines of manufacturing.

For a considerable distance the St. Lawrence forms the boundary between New York and Canada. This part of the state is sparsely populated, and the river is ice-bound for several months each year. It is not, therefore, of much commercial value to New York.

From the standpoint of power, the Niagara is of more value to the state than is any other river. Its power was first made use of in 1725, when a saw mill was erected a Fort Niagara. At the Niagara Falls there is a tremendous volume of water—on the average about 1,000,000 tons drop over the precipice each minute. The flow is remarkably uniform because the lakes serve as gigantic reservoirs. The maximum flow is only about 35 per cent. greater than the minimum. This is a great advantage commercially. It is estimated that if the entire flow could be utilized, a total of about 5,000,000 mechanical horse-power could be developed. A treaty entered into between the United States and Canada on May 5, 1910, limits the amount of power which may be developed. Both countries have nearly reached the limits fixed by the treaty. In our country about 200,000 horse-power has been developed, and in Canada nearly twice this amount.

A plan is on foot for the construction of reservoirs in various parts of New York State which will greatly increase the amount of power. In 1907 the state inaugurated the policy of making a charge for granting franchises for power development. This will greatly increase the state's revenue. The rates vary according to the amount of power developed. Water power in New York is very important, as the state has practically no coal.

In large part due to the action of the ice, New York has many lakes, such as the Finger Lakes. Her frontage upon two of the Great Lakes, especially Lake Erie, gives her a decided commercial advantage. As will be pointed out later, these lakes have an important bearing upon the climate and the agriculture of western New York.

Lake Champlain has some commercial importance because it is along the line of a natural route of travel between New York City and the St. Lawrence. As has already been shown, physical conditions in this part of the state hinder development. Most of the many small lakes in the state are chiefly important from the scenic standpoint.

Influence of the Glacier.—The results of the glacier have already received some attention. As in New England, the ice removed much soil from the uplands. Considering the state as a whole, the ice was a great benefit to agriculture. There are comparatively few boulders in New York because the surface strata of the prevailing rocks, limestone and shale, were readily ground into the soil. The ice blocked stream courses and made possible development of much power. Lake basins were formed in large numbers, some of which now serve as reservoirs, thus regulating stream flow, and most of which add a charm to the landscape.

Glacial topography is strongly marked in New York State. Drumlins are numerous between Syracuse and Rochester. Along the Mohawk and the Hudson there are great quantities of rock-flour which was deposited by the streams issuing from beneath the ice. This has led to the development of the brick and pottery industries.

Climate.—The climate of New York State is most variable in the northeast owing to the distance of this section from large bodies of water. Here the winters are long and the snowfall considerable. The western part of the state has a more uniform climate because of the influence of the lakes. These bodies of water prevent early autumn and late spring frosts. As a result, fruits are successfully cultivated; grapes, apples and peaches being grown. No part of the state receives less than 25 inches of rain per year. The annual rainfall is about 40 inches, very uniformly distributed as to months. The average annual temperature of New York City is 51° F. The yearly range is great, amounting to 43° F.

As New York is practically in the path of the average cyclonic storm as it leaves the United States, her precipitation, number of rainy days and percentage of cloudy weather are high. Buffalo has on the average 170 rainy days annually, with a percentage of cloudy weather reaching 62. New York City has 131 rainy days and cloudy weather for 50 per cent. of the time.

Mineral Wealth.—As already stated, New York State has little mineral wealth. In the Adirondack province some iron is smelted. The building stones in this region are too far from large cities and from easy means of transportation to be of great value. Salt springs led to the establishment of Syracuse, and the Mohawk valley produces much salt today.

Routes of Travel.—From the earliest times the Hudson-Mohawk has been the great route across the state. By no other route is the lift between the Atlantic seaboard and the interior so slight, the divide being crossed at an altitude of 445 feet. Naturally, this route was followed by a railroad, the first section being built from Albany to Schenectady in 1826. The great New York Central and Hudson River Railroad now follows this natural route. The Erie Railroad crosses the mountains at Castile at an altitude of 1,401 feet. The New York, Ontario and Western reaches an altitude of 1,800 feet; the Delaware and Lackawana, 1,932 feet; the Lehigh, 1,728 feet; the Pennsylvania, 2,161 feet, and the Baltimore and Ohio, 2,620 feet.

Another natural route leads from the Hudson valley northward past Lake George and Champlain and down the valley of the Richelieu to the St. Lawrence. This route is today followed by the Delaware and Hudson Railroad. In 1823 the Hudson River and Lake Champlain were connected by a canal.

On October 26, 1825, the Erie Canal was opened. Military as well as commercial considerations led to the construction of this waterway. It is said that the possibility of another war with England turned the vote in favor of the canal when the matter was before the State Legislature.

When the canal was opened the cost of shipping goods by wagon from Albany to Buffalo was $88.00 per ton. In 26 years the freight had fallen to $5.98 per ton, and it is now about $1.00 per ton. The opening of the canal gave a value to land in central New York because it afforded a means of marketing crops. Cheap transportation not only developed the state but was of great importance to the United States as a whole, and it even reduced the price of wheat in England.

The new Barge Canal, which cost the state about $150,000,000, affords twelve feet of water, and will thus be of great commercial value, although this depth is not sufficient. The old route is followed much of the way. From any point west of Buffalo the St. Lawrence route to Liverpool is shorter by 450 miles than is the Mohawk-Hudson route. This means that in order successfully to compete with the river, the Barge Canal should be much more than twelve feet deep.

Agriculture.—New York State ranks very high in agriculture. On the Lake Plains, in much of the central part of the state and in a part of the lower Hudson valley from 90 to 95 per cent. of the land area is in farms. In Hamilton County, in the Adirondack region, but 5 per cent. of the land area was in 1909 in farms. Although the population of the state increased 25 per cent. during the decade closing in 1910, the total farm area decreased 2.7 per cent.

In the total value of her dairy products New York holds very high rank. Large areas are suitable to dairying which are not adapted to tillage. The large population is another cause for the extension of the industry. Each year a very large part of the milk produced in the state was sold in this form. Milk trains from Jefferson and St. Lawrence Counties carry milk 300 miles to New York City, which consumes an enormous quantity. In addition to the counties mentioned, Oneida, Otsego, Livingstone, Monroe and Niagara Counties are important in the industry of dairying.

New York, although so important in manufacturing, is one of the leading agricultural states in the Union when the total value of farm crops is considered. In the production of potatoes, hay, buckwheat, apples, grapes and rye it holds very high rank.

Industries.—Water power, cheap transportation, an excellent harbor on the Atlantic Coast, a large state population and good markets in the interior of the United States led to the development of manufacturing.

Albany is at the head of navigation on the Hudson and is at the crossing of the east-west and north-south routes of travel. There is but one bridge over the river south of the city. An added significance is given the city because it is the state capital.

FIG. 157.—Skyline of New York City.

Troy, but six miles north of Albany, is noted for the manufacture of collars, cuffs and laundry machinery. Cohoes, just north of Troy, is situated upon falls, power from which is utilized in the manufacture of knit goods.

At Gloversville some Scotch settlers began the manufacture of gloves in 1809. Nearly one-third of the glove factories in the United States are now located there. At Little Falls the Mohawk has cut down to gneiss rock, thus producing a waterfall.

Rome is situated where formerly there was a carrying place connecting the Mohawk with the Oswego. Syracuse is located over salt deposits resulting from the fact that an arm of the sea once extended up the Hudson and across central New York. At Rochester, on the Falls of the Genesee River, power was early used in the manufacture of flour.

New York City.—From the points that have already been developed, the cause of the preëminence of New York City can be worked out. Subsidence caused the formation of a large and well-protected harbor having deep water. The important Hudson-Mohawk route leads directly to Buffalo on Lake Erie, and to all parts of the interior. New York City is today our chief seaport, largest city, and one of our greatest manufacturing centers. In 1920 its population was about 5,600,000. Because of the immense volume of business, it is our chief money market. Its very large foreign population places before the city social and political problems of unusual magnitude.

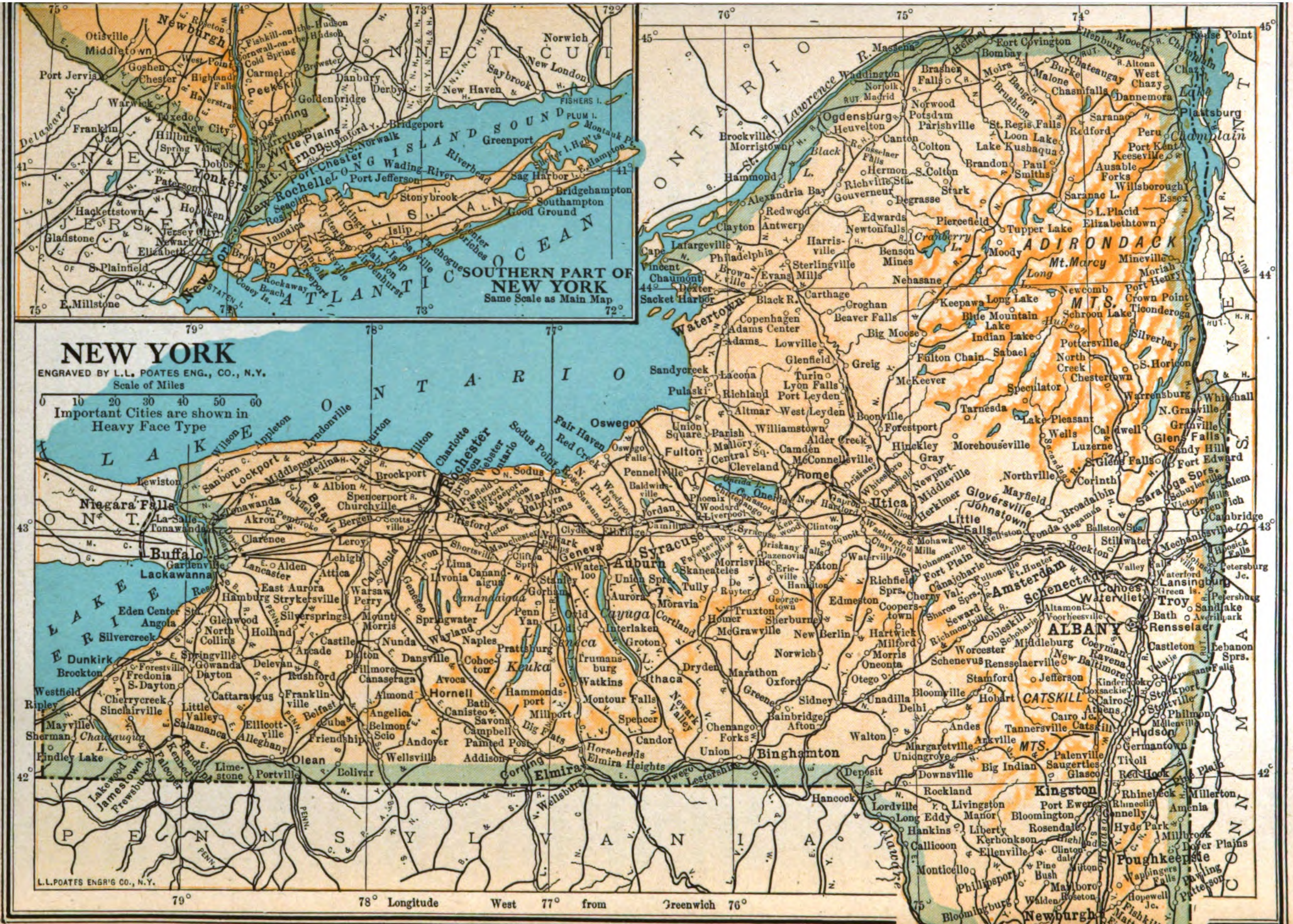
At the entrance to the lower bay there is a bar extending from Sandy Hook to Coney Island, formed by drifting shore sand. As a result of dredging, deep channels were secured. To meet the needs of the great ships of today, the Ambrose Channel was recently dredged for a distance of 7 miles. It is 40 feet deep, 2,000 feet wide and cost $6,000,000. The water in the Narrows has a maximum depth of about 120 feet and the Upper Bay affords anchorage for the largest liners.

The great disadvantage which attaches to New York is found in her limited area. This gives to real estate an enormous value and industries requiring large areas cannot be carried on there. The high price of land is responsible for the lofty buildings and the congestion of population.

Owing to the fact that the Hudson at New York is not bridged, nearly all of the railroads terminate in Jersey City. The New York Central and Hudson River Railroad enters the city by way of the Hudson valley. The New York, New Haven and Hartford enters along the north shore of Long Island Sound, and the Pennsylvania Railroad, at a cost of about $50,000,000, has constructed tunnels under the river. Thus New York is only indirectly an important railroad center.

One of the great problems which New York City has had to solve is that pertaining to an adequate water supply. Originally water was obtained from wells. In 1842 Croton River water reached New York through an aqueduct thirty miles long. In 1890 a new aqueduct was constructed, and still later a great dam was built which caused the formation of a lake twenty miles in length.

This supply was not sufficient to meet the growing needs, and on June 30, 1907, the Catskill Aqueduct was commenced. The aqueduct which conveys the water is about ninety miles long and can furnish 500,000,000 gallons per day. The total cost was about $160,000,000. The aqueduct passes under the Hudson River near West Point and under the East River to Brooklyn. Before the completion of the aqueduct, Brooklyn obtained her water supply from wells and streams. The aqueduct was completed and began supplying water in 1917.


NEW YORK
ENGRAVED BY L.L. POATES ENG., CO., N.Y.
Scale of Miles
0 10 20 30 40 50 60
Important Cities are shown in Heavy Face Type
SOUTHERN PART OF NEW YORK
Same Scale as Main Map
L.L.POATES ENG'G CO., N.Y.
Longitude West from Greenwich
LAKE ONTARIO
LAKE ERIE
ATLANTIC OCEAN
LONG ISLAND SOUND
LONG ISLAND
CONNECTICUT
NEW JERSEY
PENNSYLVANIA
VERMONT
MASSACHUSETTS
ONTARIO
ADIRONDACK MTS.
CATSKILL MTS.
ALBANY
Buffalo
Rochester
Syracuse
Utica
Binghamton
Elmira
Schenectady
Troy
Amsterdam
Auburn
Oswego
Watertown
Niagara Falls
Lockport
Jamestown
Olean
Kingston
Poughkeepsie
Newburgh
Yonkers
Mt. Vernon
New Rochelle
White Plains
New York

Buffalo.—To the fact that Nature placed the Niagara Falls between Lake Erie and Lake Ontario is due, in very large measure, the commercial importance of Buffalo. The position of the falls made it necessary that the Erie Canal should have its western terminus south of them and practically where Buffalo is now located. Hence at the foot of Lake Erie was bound to develop a great lake port and transfer point. Another important geographic factor is the Buffalo River, at the mouth of which the city was located. Dredging has afforded a large harbor and a depth of 23 feet.

Buffalo is a great grain and lumber market and an important railroad center. She produces iron and steel goods, automobiles, flour and soap in large quantities. Meat packing is a very large industry. Manufacturing is stimulated by the nearness of Niagara Falls, from which much electrical energy is transmitted. Owing to the position of Buffalo she carries on a large trade with Canada.

Distribution of Population.—Although New York ranks 29 in area, she ranks first in population. The distribution is strikingly governed by physiographic conditions. The Mohawk-Hudson depression contains a large part of the population of the state. "Except that of the Delaware, the basin of the Hudson contains a greater population in proportion to its size than any other important river basin in the United States."[1]

The influence of topography upon the distribution of population is well shown in New York State. In 1910 Essex County had 18 persons per square mile, Hamilton County 25, Cattaraugus County 48, and Chautauqua County 98.

In 1910 the foreign-born population of New York State was 30 per cent. of her total population. In this regard Rhode Island ranked first with 33 per cent., Massachusetts second with 31 per cent., and Connecticut fourth with 29 per cent. In the same year 20 per cent. of the foreign population of the United States was in New York. She had, in 1910, 35 per cent. of our total Italian-born population, 34 per cent. of the Russian-born, 20 per cent. of the French-born and 27 per cent. of those born in Ireland.

STUDIES

Discuss the influence of the Mohawk-Hudson depression upon the development of New York State. Compare the importance of the Hudson River with that of the Connecticut. Why is Lake Erie of greater value to New York State than is Lake Ontario? Why are the streams in New York so important indus-

[1]Water Supply and Irrigation Paper No. 202. p. 18.

trially? Compare the results of glaciation in New York with the results in New England. Why has Buffalo a greater number of rainy days than has New York City? What phases of agriculture are most important in New York? Discuss the advantages and disadvantages growing out of the position of New York City. Why has New York State such a large foreign population?

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CHAPTER XL

The Atlantic Coastal Plain

General Statement.—When the colonists landed upon the Atlantic shore of what is now the United States, they found a plain of varying width stretching from New Jersey southward. The fertile soil, favorable climate and numerous streams navigable for short distances led to the comparatively rapid settlement of the region. The mountain barrier on the west, with its dense forests and savage Indians, retarded the advancing frontier so that for two centuries after the founding of Jamestown nearly all of the population was found on the Atlantic Coastal Plain.

Description.—The plain averages about 40 miles in width in New Jersey and expands to 100 miles or more in the Carolinas. The rocks are geologically recent and are sedimentary in character. The plain was formerly a part of the continental shelf which has been elevated above the sea.

To the westward the plain merges into the hilly or plateau section known as the Piedmont. This region was once rugged, and after long-continued erosion was elevated. The rocks are ancient and crystalline. Faulting has occurred along the line, or rather zone, where the two areas join. In this zone are many falls and rapids, and the line connecting them is called the *fall line.*

Following the uplift the streams extended their valleys farther eastward than where they had previously terminated. Later came a slight subsidence which resulted in the drowning of the lower parts of the valleys, forming many estuaries. Because of this drowning practically every stream flowing into the Atlantic afforded transportation for a few miles inland. The subsidence converted some of the coastal portion of the plain into marshes. In the south, the marsh land is used for the cultivation of rice. Other portions of the coastal region are sandy wastes. Farther from the coast there is fertile soil, and agriculture is profitable.

In Florida geographic influences are marked. Although it has 1,000 miles of seacoast, it has no important port. Practically all of the state is less than 250 feet above sea level, and there is a large area in marshes. The precipitation is heavy, but the flatness of the land has prevented the formation of many rivers. As the state has neither water power nor coal, there is little to encourage manufacturing. There is much timber, but the semitropical climate and the fertile soil are the great assets.

As the state is essentially agricultural, the population is not large although rapidly increasing. During the decade ending in 1910 the increase was 42 per cent., a higher percentage than that of any other

FIG. 158.—Busy section of Norfolk, Virginia.

Southern State. Although the largest state east of the Mississippi River, the total population in 1919 was only about 1,000,000, and Jacksonville, the largest city, had a population of only about 80,000.

Hydrography.—Owing to abundant precipitation, the coastal plain is well supplied with rivers. The sinking of the land caused the lower portions to flow sluggishly and as a result much of the land is not well drained. Dismal Swamp, having an area of about 700 square miles and situated in southern Virginia and northern North

MAP OF ATLANTIC COASTAL PLAIN

Carolina, is an illustration. In this swampy region is Drummond Lake, the waters of which are held in place by a rim formed of decayed vegetation. "The mound of vegetable *débris* in the summit of which Lake Drummond is situated is from 20 to 30 miles broad and rises some 12 feet above tide level. The lake is nearly circular, from 2 to 2½ miles in diameter, and from 6 to 10 feet deep." [1]

Vast areas in Florida are so recent and so close to sea level that they are undrained. The Everglades in the southeastern part of the state are swampy tracts carrying considerable tree growth. The soil is rich and generally covers a limestone or coral foundation. A large part of the coastal plain is south of the glaciated area, hence there are few lakes. An exception is found in Florida, where, owing to the geological recentness and the slight altitude, lakes are numerous.

The rivers have been and are closely connected with the development of the Atlantic Coastal Plain. The tidal portions furnish cheap transportation and opportunity for the location of harbors. Points of reshipment were naturally established at the heads of navigation, and along the fall line power was developed. In addition, the river valleys furnish the best routes for railroads. The fall line may be traced from the mouth of the Raritan, in New Jersey, to Macon, Georgia. Trenton, Philadelphia, Port Deposit, Baltimore, Washington, Richmond, Petersburg, Raleigh, Columbia, Augusta, Macon and other cities are situated upon or very close to it.

The Delaware is navigable to Trenton. The river outranks the Clyde in shipbuilding. Steel is easily obtained and skilled labor and capital are at hand. Pottery making is important in the valley because of valuable clays. The Schuylkill, which enters the Delaware at Philadelphia, furnishes the city with a large part of its water supply.

The upper part of the Potomac valley is rugged. The steep slopes and the absence of lakes are responsible for floods in the lower part. This condition makes the river less valuable than it would otherwise be as a source of power. Ocean-going ships navigate the river to the fall line. The Baltimore and Ohio Railroad follows the river for its whole length, and the Chesapeake and Ohio Canal parallels it from Cumberland to Georgetown. At Great Falls, about 15 miles above Washington, there is an excellent opportunity to develop power.

The James is navigable to Richmond. Here power is developed, for the river falls nearly 50 feet at this point. Like the Potomac, the James is subject to great fluctuations. The Chowan, Roanoke,

[1] Russell: "North America," p. 63.

Tar, Neuse and Cape Fear are all navigable for a considerable distance. The Pedee is navigable almost across the state of South Carolina. Camden is the head of navigation on the Wateree. The fall line is situated 5 miles above the city and there much power is developed. The Congaree is navigable to Columbia, the capital, where power is used in the manufacture of cotton goods. The Savannah carries ships to Augusta, 250 miles inland. The Oconee is navigable to Milledgeville, and by means of the Ocmulgee ships reach Macon.

Climate.—On a large part of the Atlantic Coastal Plain the climate is very mild. A portion of Florida has a tropical climate. Our

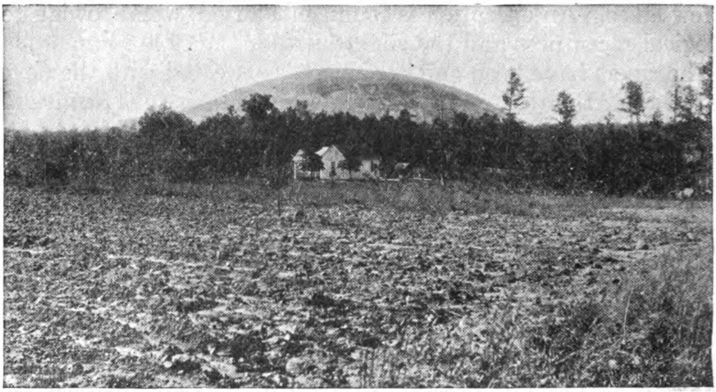

FIG. 159.—Stone Mountain, Georgia.

southeastern coast is subject to greater temperature ranges than is our western coast in the same latitude, because the climate of the former is influenced by the land more largely than is the climate of the latter.

In the southern part of the province the precipitation is heavy and vegetation is in consequence luxuriant. Bananas, pineapples and citrus fruits are grown in Florida, and upon the lowlands from South Carolina to the Gulf snow is practically unknown.

Soil.—A large part of the Coastal Plain is south of the glaciated area, and therefore the boulders of New England and the glacial soils of New York are lacking. The abundant moisture and the rank vegetation have disintegrated the rocks, forming in most sections a deep layer of fertile soil. There are areas near the coast where sand prevails to such an extent that agriculture is not profitable, and as a result there is a sparse population in these sections.

Agriculture.—The leading occupation of the Coastal Plain is agriculture. For a long time tobacco was the staple crop in Virginia. Today in the Carolinas and in Georgia cotton is the chief crop. Much tobacco, rice and sugar are produced. So much of Florida is swamps that agriculture is not possible in all sections. Citrus fruits are produced in large quantities, the state ranking next to California. In Georgia immense quantities of peaches are grown, and truck-farming is important in most of the states.

The following table shows the gradual growth of industrial conditions in the southern part of the Coastal Plain.

TABLE 49.

RURAL POPULATION IN CERTAIN STATES.[3]

State	Year	Population
North Carolina	1880	96 per cent.
" "	1890	92 per cent.
" "	1900	90 per cent.
" "	1910	85 per cent.
South Carolina	1880	92 per cent.
" "	1890	89 per cent.
" "	1900	87 per cent.
" "	1910	85 per cent.
Georgia	1880	90 per cent.
"	1890	86 per cent.
"	1900	84 per cent.
"	1910	79 per cent.
Virginia	1880	87 per cent.
"	1890	82 per cent.
"	1900	81 per cent.
"	1910	76 per cent.

Forests.—Upon the sandy areas near the coast there are forests which yield naval stores. North Carolina is one of the chief states in the Union in the production of lumber, and Florida leads in the output of naval stores. In North Carolina yellow pine and oak are the most important commercially, and in Florida yellow pine and cypress.

Mineral Wealth.—The Atlantic Coastal Plain is not rich in minerals, although it is not without this resource. North Carolina has gold, iron, copper, coal and even diamonds. In South Carolina and in Florida there are phosphate deposits of great value. Georgia exports some marble. Near Port Deposit, in Maryland, granite is

[3] Thirteenth Census (1910), vol. 1, p. 59.

quarried, for which the Susquehanna and Chesapeake Bay afford water transportation.

Manufacturing.—Largely owing to the development of power and electrical energy from water power, the Coastal Plain is rapidly developing its manufactures. No longer is all of the cotton being sent to Europe and New England to be manufactured. The raw material, the power, the cheap labor and the capital give to the South a tremendous advantage. The climate favors the development of power, since the streams are open all of the year.

Along the fall line and farther inland as well, the South is using water and electrical power in the numerous cotton mills. Over 500,000 horse-power, is now in use, and the total available energy is estimated at 3,000,000. The energy is in many cases transmitted 50 or even 100 miles. It is estimated that within 60 miles of Charlotte, North Carolina, there is 100,000 horse-power available.

Charlotte and Raleigh, North Carolina; Richmond, Virginia; Greenville, South Carolina; Atlanta and Augusta, Georgia, are a few of the cities to which the streams furnish electrical energy.

TABLE 50.

MANUFACTURE OF COTTON GOODS IN 1910.

State	Value	Rank	Per cent. of total output in U. S.
Massachusetts	$186,462,313	1	30
North Carolina	72,680,385	2	11
South Carolina	62,929,585	3	10
Georgia	48,036,817	4	7

There are a larger number of cotton mills in North Carolina than in Massachusetts, the figures for 1910 being 281 and 182. In the decade closing in 1910 Massachusetts increased the value of her cotton output 67 per cent.; in North Carolina the increase was 156 per cent.; in Georgia 160 per cent.; in Alabama, 172 per cent., and in Virginia, 182 per cent. New England seems certain to lose her prestige in the cotton industry owing to the greater advantages possessed by the cotton growing states.

CITIES

Philadelphia.—The greatest city on the Coastal Plain south of New York is Philadelphia, at the junction of the Delaware and Schuylkill Rivers. Although situated 103 miles from the sea, it is reached by ocean-going vessels. This is due to the drowning of the lower valley of the Delaware. Excellent facilities for shipment both by rail and water have placed the city close to the front among our seaports. Its easy access to coal, iron and petroleum has caused it to become a great manufacturing center.

Philadelphia obtains her water supply chiefly from the Schuylkill River, although the Delaware furnishes some. The water is filtered before being used.

For the purpose of showing more intelligibly the industrial

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FIG. 160.—Looking north on Broad Street toward City Hall, Philadelphia.

conditions, the Census Reports include Philadelphia in a great metropolitan district. There are in the district six cities in addition to Philadelphia, besides many boroughs and townships. Chester is the only one of the six cities situated in Pennsylvania; the others, Beverly, Burlington, Camden, Gloucester and Woodbury, are in New Jersey.

In the metropolitan district there are a large number of manufacturing establishments. These employ in the aggregate about 500,000 persons. Several hundred million dollars are paid out annually in wages and salaries, and the value of the goods manufactured yearly is enormous. Most of the establishments are in Philadelphia; and the value of the goods manufactured in this city is probably equal to three-fourths of the value of those made in the district.

From the standpoint of the output, the woolen and worsted industry ranked first, printing and publishing second, the refining of sugar third, and foundries and machine shops fourth. The making of men's and women's clothing is one of the leading industries. Petroleum is refined, carpets made, and ships and locomotives built. The city is our greatest leather center. In 1920 the population of the city was about 1,800,000, an increase of 17 per cent. as compared with the population of 1910.

Historically Philadelphia is of great interest. It was founded by William Penn, and for years was the home of Benjamin Franklin. In Independence Hall, which yet stands, the Declaration of Independence was signed and the Constitution of the United States drawn up. This building is the home of the Liberty Bell, which in 1915 was taken across the continent and exhibited in several of our western cities. Before the founding of Washington, Philadelphia was for a time the national capital.

Baltimore has a splendid situation on the Chesapeake Bay 170 miles from the sea. It has a deep-water harbor due to the drowning of the lower valley of the Patapsco River, and is within easy reach of the coal, iron and petroleum of Pennsylvania.

It has good transportation facilities, and is an important port and manufacturing center. Favorable conditions for the growth of oysters in the bay have led to the development of the oyster industry. Because of the mild climate, fruits and vegetables are grown, and Baltimore cans and exports large quantities.

Washington, our national capital, is not important as a seaport or as a manufacturing center. It is situated at the junction of the Anacostia and Potomac Rivers in the District of Columbia, the area of which is about 100 square miles. The valley of the Potomac affords a natural route of travel across the mountains. The Great Falls are about 15 miles up the valley from Washington, and there water is obtained and light and power developed.

In 1800 Washington became the capital of our country. The city is quiet, clean and beautiful. The very large number of trees adds much to the charm of the city. Since 1872 about one-half a million dollars have been expended in the purchase of shade trees. The need of parks is not felt in Washington, as it is in other large cities, for it is almost as though a section of the country had been enclosed in the city.

Pennsylvania Avenue, the main business street, leads from the Capitol to the White House. Other noted buildings are the Congressional Library, where must be deposited a copy of every book that is to be copyrighted, the Corcoran Art Gallery, the Smithsonian Institution, the Printing Office, the Mint, the Naval Observatory, and the Pan-American Building.

Savannah, at the mouth of the Savannah River, has a large and productive back country. It exports great quantities of cotton, and is the leading source of rosin and turpentine in the world. The production of turpentine has led to the manufacture of barrels on a

FIG. 161.—The Capitol, Washington, D. C. The corner-stone of this building was laid in 1792. President Washington and Major P. C. L'Enfant selected the site. Much of the old Capitol was burned by the British in 1814; after the War of 1812, it was rebuilt and extended from time to time as more space was needed for the expansion of the business of the Federal Government.

large scale, and also to the making of paints and oils. The cotton seed, obtained in such large quantities and formerly wasted, is now used in the manufacture of table oil, cottolene and soap.

Atlanta has come into prominence partly because it is situated close to the southern end of the Appalachian Mountains, where railroads can easily cross the system. For 350 miles north of the city there is no easy route across the mountains. Because of its position Atlanta is sometimes called the "Gate City." The situation of the city and the productive country surrounding it have caused Atlanta to become an important railroad center. It is also important industrially because it is located close to iron, coal and limestone, and because cotton is grown extensively on the fertile lands to the south. In 1920 Atlanta had a population of 200,000, a gain of 29 per cent. as compared with the population of 1910.

STUDIES

What advantages did the Atlantic Coastal Plain offer to the early settlers? By means of a wall map trace the position of the fall line, and locate the important cities situated upon it. Why is there so much truck farming on the southern part of the plain? Why is shipbuilding so important on the Delaware River? What conditions account for the rapid increase of manufacturing in the southern section of the Atlantic Coastal Plain? What advantages in the location of Philadelphia?

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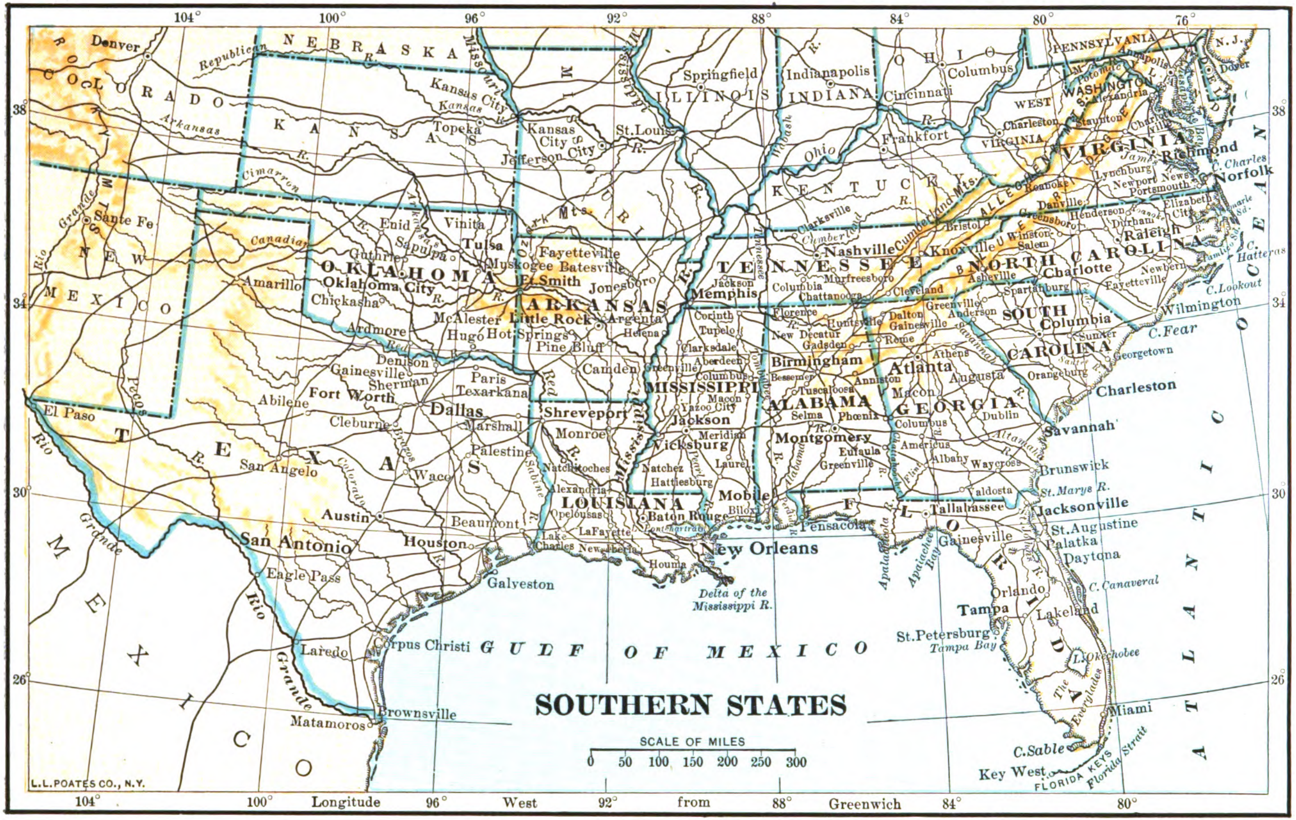


MAP OF THE SOUTHERN STATES

CHAPTER XLI

The Gulf Plain

General Statement.—The Gulf Plain is a continuation of the Atlantic Coastal Plain. As here considered, it constitutes the states bordering upon the Gulf of Mexico rather than the plain proper. Like the Coastal Plain, the Gulf Plain has been elevated from beneath the sea, and following the elevation came a slight subsidence. As a result, the lower courses of the streams have been made tidal, there is considerable marshy land close to the coast and there are few good harbors. Owing to the sluggishness of the streams, shore currents have formed sand bars and islands across the entrances to many of the bays.

Upon the lowlands much rice is grown. A little farther inland is a sandy belt of rather infertile soil. Next comes the black soil belt, in which the soil has been formed by the decay of the underlying limestone. This is the great cotton belt, and here the negro population is the largest. Jackson, Mississippi, and Montgomery, Alabama, are in this belt.

South of Montgomery is a ridge called a *cuesta*. It has a steep slope to the north and a more gentle slope southward. It is composed of resistant rocks which have weathered slowly. To the north of the cuesta are less resistant rocks, the more rapid decay of which has produced the black soils already spoken of. The weak, sandy soils of the cuesta support a sparse population, while the rich lands to the north are densely populated.

Climate.—Among the geographic factors very important in shaping the development of the Gulf Plain is climate. This province has an abundance of rainfall, largely furnished by the winds which blow from over the Gulf. The mean annual precipitation varies from 50 to 60 inches in most of the area. In the western part of Texas there is a large semi-arid region known as the Staked Plains. Here the rainfall decreases to 10 inches annually. This aridity results from the fact that the Rocky Mountains deprive the westerlies of moisture and the rain-bearing winds from the Gulf are deflected to the east (right) by the deflective influence of the earth's rotation.

The temperature upon the lowlands is high. Snow is practically unknown and the growing season is long. These climatic conditions are well adapted to the growing of cotton, sugar cane, rice and semi-tropical fruits. They also fostered the institution of slavery. Neither the large plantations nor the slave labor was conducive to industry in a broad sense, hence large cities were slow to develop. The high humidity makes a given temperature harder to endure than it would be in a dryer climate. This is another factor that has played a part in retarding development.

Rivers.—Only one of the rivers of this province is important from the standpoint of navigation—the Mississippi. Before the days of railroads it was all-important to the states bordering upon it. It is yet used to some extent, but railroads have taken a large part of the business formerly done by the river. Boats run from New Orleans to Memphis, others from Memphis to St. Louis, and yet others from St. Louis to St. Paul. From the earliest times the Mississippi has been an almost constant source of danger to life and property because of its floods. The river has built up a tract of deep, fertile soil having an area of more than 10,000 square miles. As the stream is constantly aggrading in its lower course its bed is higher than the adjacent land on either side. This has necessitated the construction of levees.

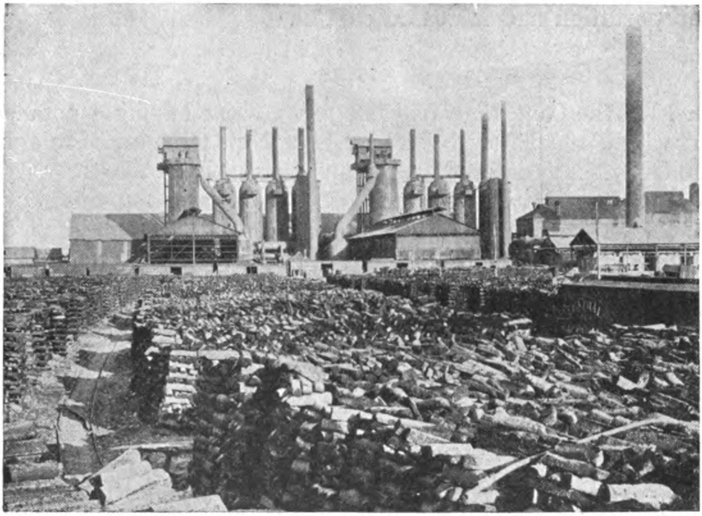
The Rio Grande, although a large river, is navigable for a few miles only. It is subject to great fluctuations in volume, but for the most of the year it is a shallow stream which shifts its channel. Much of its water is used for irrigation. Boats of light draft make some use of the Colorado, the Brazos, the Red and other streams. In the same sense the Alabama is navigable to Montgomery. In the highland sections some power is developed.

Forest Resource.—The Gulf Plain is rich in timber. For a number of years Louisiana has been one of the chief lumber-producing states, and has frequently ranked first. Texas has a vast forest area stretching from the Nueces on the south to the Red River in the north. It is many miles in width and lies to the west of the low coastal strip. The other Gulf States have much timber. On the lowlands the southern or long-leaf pine predominates, while on the uplands there is much hardwood. As a result of the climatic conditions lumbering is carried on all of the year. The average cut is about 3000 board feet per acre. In addition to lumber, the forests yield naval stores.

Mineral Wealth.—For a long time the mineral wealth of the Gulf Plain lay little developed. Some coal was mined in Alabama before the Civil War, but not until 1895 did the annual production reach 5,000,000 tons. For a number of years Alabama has been one of the leading states in the production of coal.

In 1881 iron was discovered near Birmingham, and this caused a boom in the city and in the surrounding country. Alabama ranked third as a producer of iron ore in 1915, being exceeded by Minnesota and Michigan.

Texas has become very prominent as a producer of petroleum. Louisiana has a valuable deposit of sulphur near Lake Charles.



Reproduced by permission of The Philadelphia Commercial Museum.

FIG. 162.—Blast furnace and pig iron store-yard at Birmingham, Alabama. The pig iron is ready to go to the steel mill to be rolled into rails and all kinds of structural metal.

The greatest known phosphate beds lie west of Tampa, Florida. Building stones are found in several localities, and limestone for flux exists near Birmingham. The province yields salt and natural gas also.

Industries.—Preceding the Civil War agriculture was the all-important industry, and for many years after its close the people devoted their energies to restoring the country to its former condition. Lack of capital was a great obstacle. Agriculture is yet the leading industry. As had been shown, the mild climate, the abundant rainfall, and the fertile soil greatly favored farming. Growing markets in the North as well as at home, improved systems of transportation and agricultural education are human conditions which are doing much for the tiller of the soil. Although cotton is the chief crop, truck farming is rapidly developing.

Fishing and oystering are carried on to some extent in the Gulf, the oil industry in Texas, the production of sulphur in Louisiana, the mining of iron and coal in northern Alabama, cattle raising in Texas and lumbering in all of the states. The manufacture of iron, steel and cotton goods is now assuming much importance. This is due to the development of coal, iron and water power, improvement in transportation and increased capital.

CITIES

In 1920 the Gulf Plain had but seven cities having a population of more than 100,000 each. These were New Orleans, Birmingham, Memphis, San Antonio, Dallas, Houston and Fort Worth.

New Orleans was in 1920 the largest city and the chief port on the Gulf Coast. Its situation was chosen by Bienville, Governor of Louisiana, in 1718. It is 110 miles from the Gulf and just where a bend in the Mississippi brings the stream close to Lake Pontchartrain. This was a point of much advantage before the days of steamboats, for sailing vessels found even the slow current of the Mississippi an obstacle to up-stream travel.

Standing at the entrance to the Great Mississippi Basin, New Orleans is in a position which is very favorable for commerce. In spite of this, a great port could not have developed here had it not been found possible, by means of the jetty system, to maintain deep water in one of the "passes" at the seaward end of the delta. The river has a width of about one-half mile and the depth ranges from 40 to about 200 feet.

The products of the area tributary to New Orleans, cotton, rice, sugar, molasses, tobacco, lumber, are exported to various parts of the world. Among the important imports are bananas, coffee, jute for sacks, rubber, hides and skins and machinery. The railroads now do much of the business formerly done by the river. The opening of the Panama Canal has brought New Orleans thousands of miles nearer to San Francisco, and has given it a corresponding advantage with respect to all of the ports on the western coast of North and South America.

In its lower course the Mississippi aggrades its bed, which is now slightly higher than the adjacent land on either side. Because of this, New Orleans must be protected by means of levees. It is fortunate for the city, as well as the whole delta, that the Missouri and the Ohio are not in flood at the same time.

The saturated condition of the ground has until recently made it impossible to erect great buildings, have basements or an adequate sewer system. This difficulty is being overcome by pumping the

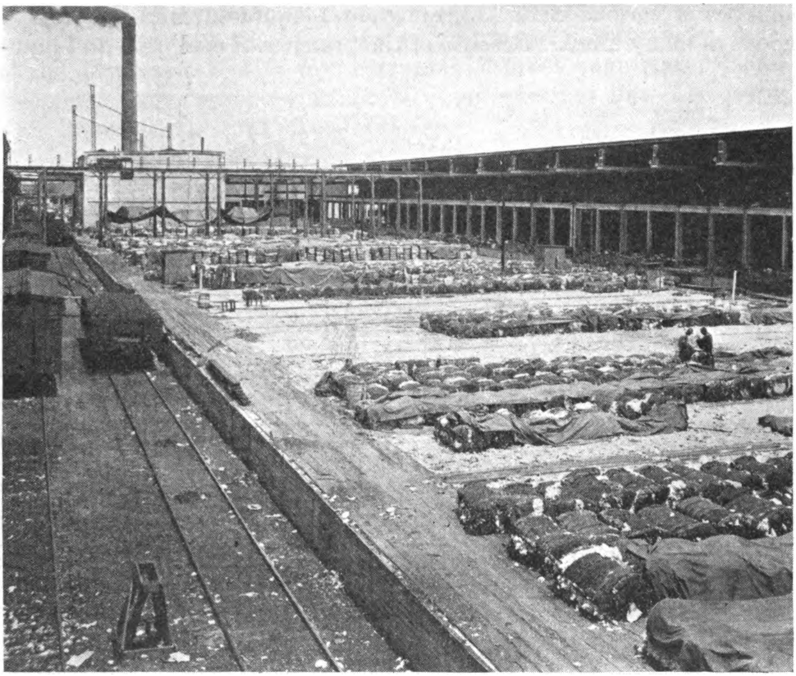


FIG. 163.—Section of the new cotton dock, New Orleans, La. Capacity 600,000 bales.

water out of the soil. A supply of good drinking water is obtained from the river above the city, and by a process of filtration is rendered safe for use.

One of the important industries of New Orleans is the refining of sugar. This is due to the large production of sugar in the region tributary to the city.

Birmingham is the second largest city in population. At its present rate of growth it will overtake New Orleans within a few years. According to the census of 1920, Birmingham had a population of 178,000. Her gain during the decade closing with 1920 was

34 per cent. Of the cities in the United States each of which in 1920 had a population of 100,000 or more, Birmingham ranked high in the percentage of gain.

As already pointed out, the development of the mineral resources of northern Alabama caused great activity in Birmingham. To the south is the rich cotton belt with its large population, calling for supplies of various kinds. Birmingham manufactures iron and steel goods of many kinds. Because of the presence of coal, iron and lime-

FIG. 164.—Galveston sea wall.

stone, Birmingham can produce pig iron at a very low cost. Steel rails, rods, wire, pipes, plows, machinery, stoves, boilers and structural iron are among the products. In the nearby town of Bessemer, steel of this name is made.

Memphis, the third city in population of the Gulf Plain, has an important position upon a bluff out of the reach of the floodwaters of the Mississippi. Hardwood lumber is shipped because the forests in the region supply this commodity. To some extent furniture is manufactured. The city exports much cotton, and is quite an important railroad center.

Galveston.—The rapidly growing production of cotton in Texas necessitated the securing of a deep-water harbor. This advantage was obtained on the north end of Galveston Island, where the government built jetties. The channel has a depth of about 30 feet. Here is located the city of Galveston, which is two miles from the mainland but is connected with it by a causeway carrying rail and wagon roads.

In 1900 the city suffered terrible loss as a result of a tidal wave caused by a hurricane. A sea wall 4½ miles long and 17 feet high has since been constructed at a cost of $1,500,000. This, it is believed, will protect the city. As an additional improvement much of the city was raised 14 feet by means of great quantities of sand, for the transportation of which a canal was dug into Galveston. This improvement cost $2,000,000.

STUDIES

To what extent are the industries on the Gulf Plain the outgrowth of climatic conditions? Explain the difference between the climate of the coastal and the interior sections of Texas. What does the great depth of the lower Mississippi River indicate? Why does the volume of the Rio Grande River fluctuate so much? Discuss the development of the mineral resources of the Gulf Plain. Why is not New Orleans at the mouth of the Mississippi? What are the factors which explain the rapid growth of Birmingham?

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CHAPTER XLII

The Appalachian Province

General Statement.—The Appalachian mountain system extends from northern Alabama and Georgia to New England. For about 1,000 miles it forms a barrier between the Atlantic Coastal Plain and the interior of our country. To cross it one must travel 150 miles or more. Nowhere are these mountains remarkable for their height, the most lofty peak, Mount Mitchell, rising to an altitude of 6,711 feet.

Lofty mountains once rose where now the Appalachians exist. During many centuries they were slowly lowered through erosion and atmospheric agencies. Then an uplift occurred which gave the rivers new energy, so that in many places they have carved deep, steep-walled valleys. The uplift took place so slowly that the streams maintained their ancient courses, with the result that many of them now flow directly across ridges.

The Appalachian Province may be thought of as consisting of the Piedmont on the east, the Blue Ridge, the Appalachian Valley, the Alleghany Front and the Alleghany Plateau. The Blue Ridge, which has a maximum width of about 75 miles, is composed of folded rocks. The gentle slopes are soil-covered and were originally densely forested. Because of these conditions much agriculture is carried on and there are beautiful summer homes and good roads.

The central valley is in reality made up of various parallel valleys with intervening mountain ridges. Many different names are locally applied. It is an agricultural area of much value, and in Colonial days was inhabited by the Cherokees and other Indians.

The Alleghany Front presents a steep slope to the southeast and a gentle slope to the northwest. It merges with the Alleghany Plateau, in which the rocks are practically horizontal.

Economic Relations.—In Pennsylvania and West Virginia the province is exceedingly rich in coal and iron, and mining is an important occupation. Again, in the southern portion there is vast mineral wealth. Our most extensive hardwood forests exist in these mountains. In these highlands rise the streams which are furnishing the power which is doing so much for the industrial life on the Atlantic Coastal Plain.

Relation to Travel and Settlement.—In the early days the moun-

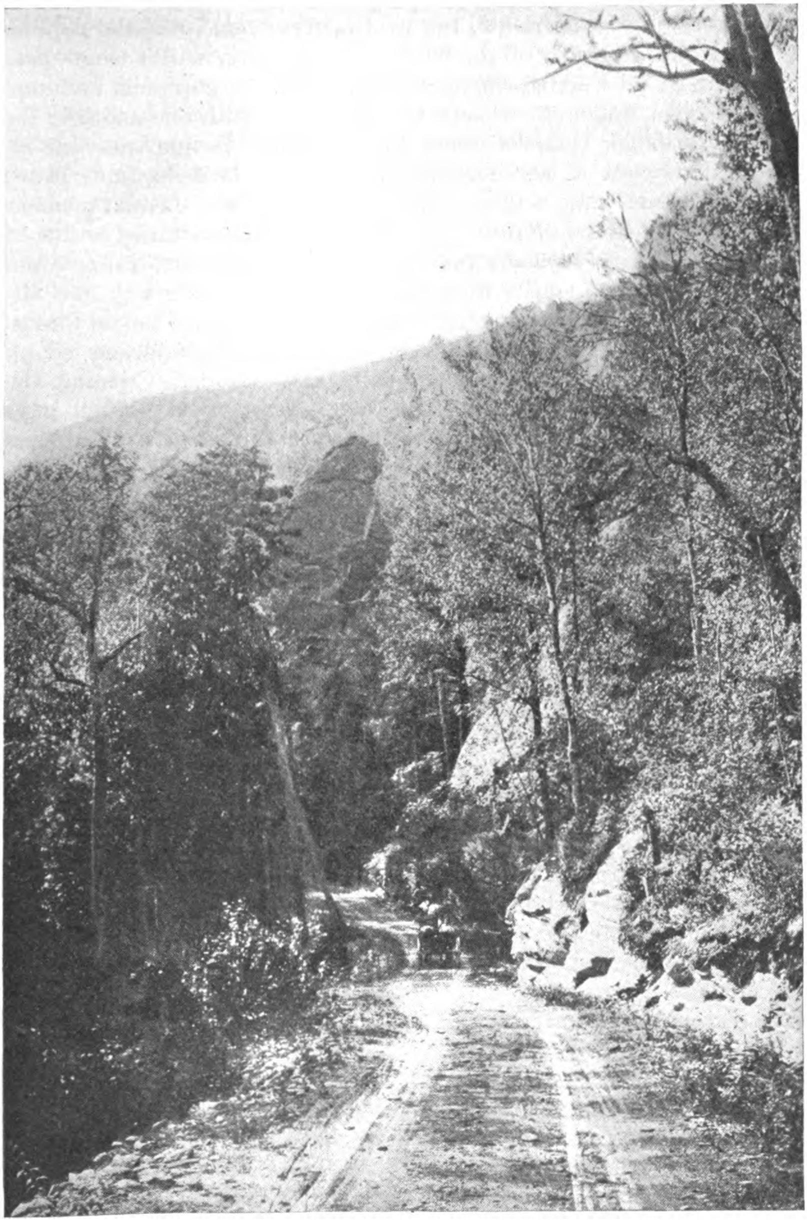

FIG. 165.—On the southern slope of Grandfather Mountain. (Senate Document No. 84.)

tains were quite a barrier to the westward movement of the population. Nowhere south of the Mohawk depression will a single pass carry the traveler across the mountain system. A gap must be found in each ridge, and as these gaps are not in line with one another, the journey is longer than it otherwise would be. People traveling on foot or on horseback were seriously impeded by the dense underbrush which covered the mountains, and the Indians were a constant menace.

Before the days of railroads, as at the present time, routes of travel were in large measure guided by valleys. Hunters, trappers and other venturesome spirits were the first to work their way into the fertile valleys of the Appalachian Province and on the Central Plains.

The route from eastern Pennsylvania to Fort Duquesne led up the Susquehanna to where Harrisburg now stands. Crossing the river, the trail led southwest and then nearly west through gaps where two of the southern tributaries of the Juniata head, and then south to a gap through which the Youghiogheny flows and thence down its valley to Pittsburgh.

To reach the Kentucky region from Pennsylvania, the path continued southward along the valley from Harrisburg, crossed the Potomac where now is Harpers Ferry, and led up the valley of the Shenandoah to its head near Staunton. Continuing southward, it crossed the headstreams of the James, near which a trail from Richmond joined it. Onward it led for many miles, followed New River to the Holston, down its valley and through a gap to the Clinch, which it crossed and led down the Powell to the famous Cumberland Gap, 1,600 feet in elevation. From Fort Chiswell, at the head of the Holston, on to the Blue Grass region the trail was known as the Wilderness Road.

Following upon a map the course of this one trail across the Appalachian Barrier will give one a good idea of the obstacles encountered by those who traveled in early days. Wagon roads have succeeded the trails, and railroads the wagon roads. South of the Roanoke the difficulty in crossing the mountains increases owing to the increase in altitude. Until 1880 no railroad crossed the system for a distance of 350 miles south of this river. The altitudes at which a number of railroads cross the Appalachians are given on page 397.

Climate.—The mountains are sufficiently elevated to cause generous precipitation. In the north there is much snow, which lingers in sheltered places until late in the spring. In the southern part the winter climate is mild because of the influence of latitude. The climatic conditions worked against the cultivation of cotton, and hence against slave labor. The mountain dwellers were a serious menace to the South during the Civil War, for they furnished large numbers of soldiers to the Northern armies.

Effects of Isolation.—The effects of the most isolated parts of the mountains upon the present-day inhabitants is plainly marked. Some of these districts have very inadequate means of communicating with the outside world. Table 51 shows certain conditions as to the population of the counties in western North Carolina and Table 52 gives similar information concerning the eastern tier of counties in Tennessee.

TABLE 51.

POPULATION IN WESTERN NORTH CAROLINA.

County	Density per square mile	Per cent. of negro pop.	Per cent. native white parentage
Alleghany	33	4	95
Ashe	45	3	97
Cherokee	31	4	96
Clay	18	4	96
Graham	16	0	97
Haywood	38	3	97
Madison	46	3	97
Mitchell	46	3	97
Swain	18	2	90
Transylvania	19	3	90
Watauga	39	2	98
Yancey	40	2	98
The State	45	32	67

TABLE 52.

POPULATION IN EASTERN TENNESSEE.

County	Density per square mile	Per cent. of negro pop.	Per cent. native white parentage
Carter	56	3	96
Cocke	45	5	94
Greene	51	4	95
Johnson	45	3	97
Monroe	31	6	94
Polk	33	2	97
Sevier	38	2	98
Unicoi	36	2	98
The State	52	22	76

These figures make it plain that, with few exceptions, the mountain counties are below the average in density of population. The percentage of negro population is very low because the conditions were not favorable to slave labor. The people are practically all of native white parentage because the region is not industrial, its agricultural conditions are not such as to attract immigrants, and it is far removed from the lines of westward travel.

Owing to lack of easy contact with the outside world, many customs persist which have long since disappeared from sections less remote. Until quite recently many of the people dressed in homespun and carried their wheat to the mills, thus obtaining their supplies of flour from their own grain.

STUDIES

Why were the Appalachian Mountains so important in determining the distribution of the early population? How do the mountains influence the distribution of population at the present time? How are the mountains related to the nationality of the present population? What are the evidences of geological old age in this province? Why are there so few lakes in the southern part of the Appalachian Mountains? Give specific examples of the influence of the Appalachian Mountains upon life at the present time.

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CHAPTER XLIII

THE EAST CENTRAL STATES

General Statement.—The St. Lawrence River and the Great Lakes constitute the most important inland waterway in the world. This waterway reaches into a part of the United States the geographic environment of which is, for the most part, wonderfully favorable. The topography encourages agriculture and road building. The climate, although continental, is adapted to the staple crops of the temperate zone. The soil is fertile, and in the north there is yet much timber. Considerable water power is available and the mineral wealth is enormous. In addition to the Great Lakes and the New York Barge Canal, there are other lines of water transportation, chiefly the Mississippi and Ohio Rivers. A network of railroads places every part of this large area in easy communication with all sections of the United States. As a result of the natural resources and excellent means of transportation, the five states in this group, Ohio, Indiana, Michigan, Illinois and Wisconsin, had in 1920 about 20 per cent. of the total population of our country.

Influence of Topography.—This area has comparatively little relief. Generally speaking, the surface is rolling or level. In Indiana and Illinois there are extensive prairie plains varying from 400 to 600 feet in altitude. Illinois lies wholly in the prairie plains. In the area between the Scioto and the Great Miami some of the hills reach an altitude of more than 1,500 feet, and in northern Wisconsin there is some rather rough country which exceeds 1,500 feet in altitude.

In most of the region the levelness of the area greatly encourages settlement. Many of the streams are navigable by boats of light draft, and wagon and railroads are easily constructed. The wide stretches of level land made the use of farm machinery profitable.

The divide between the St. Lawrence and the Mississippi drainage is so insignificant that in early days two important canals connected Lake Erie with the Ohio River. This same condition made possible the construction of the Illinois and Michigan Canal and later the Chicago Sanitary and Ship Canal.

Influence of the Glacier.—Most of this great area was glaciated, and glacial topography and glacial lakes are familiar features, especially in the north. The choking of the streams by the drift caused many falls and rapids where power is now developed. It is estimated that Wisconsin has about 1,000,000 horse-power in the form of stream energy, only about one-fourth of which was in use in 1919.

Much of the soil is of glacial origin. The glacier did much more in preparing the soil for the use of man than it did in New England, because the rocks are less resistant, being for the most part sandstones and limestones. In the central part of Wisconsin is the *Driftless Area*. Here the soils are residual and are largely the result of the disintegration of sandstones. Farms in this section are not so productive as they are in the glaciated area farther south, and are therefore much less valuable. Much clay was deposited by the streams which flowed out from under the ice. This has led to the manufacture of brick, tile and pottery.

Climate.—The great distance of this area from the ocean results in a continental climate. The prevailing westerly winds bring to these states the high summer and the low winter temperatures of the areas to the west. On the south and east shores of the lakes the seasonal temperature ranges are not so great as they are on the west shores of these bodies of water.

So great is the volume of water in these lakes that they never freeze over, although ice forms along the shores, closing navigation for several months each year. Because of the moderating influence of the water, late spring frosts are less likely to occur near the east than the west margins of the lakes. Consequently fruit buds are less likely to be killed on the east shore, and the southern part of Michigan produces peaches in large quantities, although the parts of Wisconsin and Illinois in the same latitudes do not.

In the southern part of this section the growing season is much longer than it is in the northern part. This is a result of latitude. In the northern part of Wisconsin the length of the growing-season varies from 100 to 120 days, although in the southern part of Illinois it is about 180 days. Corn therefore thrives better in central and southern Illinois than it does in northern Wisconsin. Peaches, strawberries and other small fruits are raised in abundance in southern Illinois.

As the average path of the cyclonic disturbances lies over the Great Lakes, there is great variability in weather conditions. There is much cloudiness, and the relative humidity is high. Precipitation is in all parts ample for agricultural purposes. It increases from north to south, where it is approximately 40 inches annually. The precipitation is fairly uniformly distributed as to months, although there is a minimum in the late summer. This is an advantage to ripening grain.

There is a heavy seasonal snowfall in the north and central sections, and blizzards are not uncommon. Transportation and communication are occasionally seriously interfered with. The removal of snow from the streets of Chicago costs a considerable sum annually. In many sections the severe winter weather is taken advantage of in the harvesting of ice on lakes, ponds and streams. Numerous plants for the manufacture of ice have reduced the importance of natural ice, however.

The Forest Resource.—Much of this area was originally heavily timbered. In the north this timber was largely white pine and hemlock. Farther south there were splendid forests of hardwood. Much of this area was cleared and the timber burned in order to establish farms. Owing to the fact that markets could easily be reached by water, lumbering has been an industry of vast importance.

Much timber yet remains in the northern parts of Wisconsin and Michigan. In 1920 about one-third of Wisconsin was classed as wooded land. Until very recently white pine was the chief commercial lumber, but hemlock now holds first place.

The many streams furnished a means of transporting logs and the power for sawing, and towns developed at favorable sawmill sites. Owing to rapid deforestation, the sawing of lumber has declined. In many cases the same sites are used in the manufacture of pulp, furniture, sash, doors, blinds and boxes of various kinds. Thus much small material, such as was formerly wasted, is used. Many tanneries have been established in Wisconsin because of an abundance of tanbark and the great numbers of hides to be obtained in Chicago and Milwaukee.

The Mineral Resource.—The mineral wealth of this region is great. Coal is mined in Illinois, Indiana and Ohio. The coal of Ohio is quite largely mined in the Hocking Valley, and hence much of it is shipped down the Ohio River. South of Ottawa, Illinois has immense deposits of coal. Wisconsin was above water during the Carboniferous Age and hence has no coal.

Both Indiana and Ohio produce petroleum. In Indiana it is found in the arch which extends across the central part of the state from southeast to northwest. From the region of Lima, Ohio, oil is piped to Chicago and to the Atlantic coast.

In 1884 gas was discovered in Ohio and three years later in Indiana. Before it was realized that the supply was exhaustible much of it had been given away or wasted. In spite of this Ohio yet holds a high rank among the states as a producer of natural gas.

Iron County, Wisconsin, has large deposits of iron, and the state produces so much zinc that its value is greater than that of the iron. In the Northern Peninsula of Michigan there is a great deal of copper. Sandstone, limestone, shale and clay are quite widely distributed. In Berea, Ohio, there is the largest grindstone factory in the world. This has resulted from the deposits of sandstone especially adapted to the making of grindstones. At East Liverpool and Cincinnati

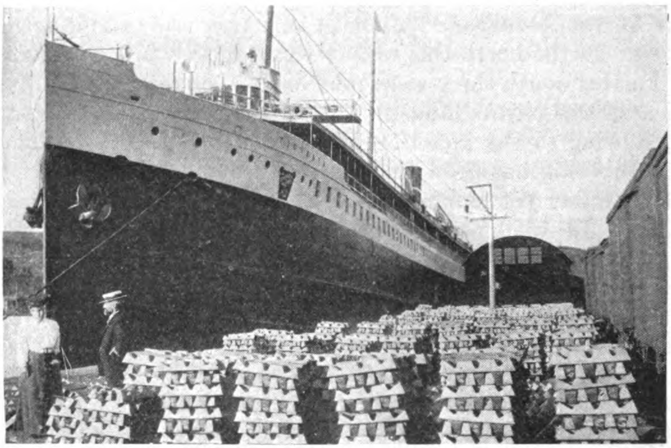

FIG. 166.—Copper ingots ready for loading, Michigan.

there are pottery works, and the extensive clay deposits in and near Chicago are used in the manufacture of bricks on a very large scale.

In the neighborhood of Saginaw, Bay City, St. Charles and Mt. Pleasant, Michigan, and in Ohio, much salt is produced. Wisconsin is one of the leading states in the production of mineral waters.

Hydrography.—During the open season on the Great Lakes, which is approximately from April 10 to December 1, large quantities of iron, copper, lumber and wheat are shipped eastward by the lakes. Coal is the most important item in the westward-moving freight. As has already been shown, the Great Lakes influence climate and hence the products of the soil. They have played a prominent part in determining the location of cities and the routes followed by railroads. Each of the states has lake frontage, although Indiana has but little, and recently commenced to develop a lake port. Michigan has the advantage of frontage on four of the lakes. The large number of small lakes, especially in the northern states of the group, have become centers for resorts to which hunters, fishermen and seekers for recreation go during the summer.

The Mississippi is navigable, and during early days was an important line of trade and travel. The rapid development of railroads has greatly decreased river trade. The Ohio forms the southern boundary of three of the states, and is of considerable commercial importance. There is regular boat service between Cincinnati and Memphis, a distance of 749 miles.

The Illinois River and valley have exerted a marked influence upon the development of Illinois. One-half of the state is in this basin. Many of the early settlers were from the South. They went down the lower Ohio to the Mississippi, and by this route reached the navigable Illinois and the fertile lands in its valley. In 1826 steamboats began to navigate the Illinois. As originally planned, the northern boundary of Illinois extended due westward from the southern end of the lake. Congress, fearing that the state would be settled by people from the South, changed this so as to give some lake frontage. This gave contact with the East as soon as the Erie Canal was opened. Until some years after this event the produce of the Illinois valley was shipped to St. Louis or New Orleans by flatboats. The Wabash, the Great Miami, the Scioto, the Muskingum are all navigable for short distances. The Ohio and Erie Canal connected Portsmouth and Cleveland. It follows the valley of the Scioto from Columbus southward. Another canal was built from Toledo to Cincinnati, making use of the valleys of the Maumee and the Great Miami.

TABLE 53.

RAILWAY STATISTICS FOR YEAR ENDING JUNE 30, 1916.[1]

States	Miles	Miles per 100 square miles of territory	Miles per 10,000 inhabitants
Wisconsin	7,693	13.92	30.86
Illinois	12,141	21.67	19.81
Indiana	7,475	20.74	26.59
Ohio	9,121	22.39	17.77
Michigan	8,875	15.44	29.15
Utah	2,137	2.60	49.60
New Jersey	2,337	31.11	7.98

[1]Statistical Abstract of the United States, 1917, p. 296.

Land Transportation.—The fertile soil, the forests and the mineral wealth, together with the water routes, have led to a rapid development in population. The same conditions have caused the building of many railroads. The southward extension of Lake Michigan has resulted in making Chicago a great railroad center.

Industries.—Except in the forested sections, agriculture is highly developed. More than nine-tenths of the land area of Ohio and six-tenths of that of Wisconsin is in farms. The cereals, hay and potatoes are very important crops. In the southwestern part of Michigan, in southern Illinois and on the lake plain in Ohio peaches and other fruits are grown.

Wisconsin is now the first state in the Union in the dairying industry. It has several thousand cheese plants and creameries. The industry is most highly developed in the southern part of the state because there are the clayey soils which retain water and therefore promote the growth of grass. Hilly areas in various states in this region are in some cases used for dairying because rapid erosion unfits them for the most successful agriculture. Dairying is most important in the section adjacent to Chicago, as there is a very large demand for the products.

In Illinois the great acreage devoted to corn has led to the hog industry. Great quantities of corn are used in the distilling of liquors and in the manufacture of glucose. Owing to its position, Peoria leads in this work.

The extensive development of agriculture in these states has led to the manufacture of farm machinery on a large scale. Cincinnati, Indianapolis, Peoria, Rock Island, Moline and Chicago are noted centers.

With the great increase in population manufacturing has had a rapid development. In 1910 the urban population in these states was as follows: Ohio 56 per cent., Indiana 42 per cent., Illinois 63 per cent., Michigan 47 per cent., and Wisconsin 43 per cent. Table 54 shows the development of manufacturing.

TABLE 54.

VALUE OF MANUFACTURES PER CAPITA IN EAST CENTRAL STATES

State	1849	1910
Ohio	$32.00	$302.00
Indiana	19.00	214.00
Illinois	19.42	340.38
Michigan	28.00	244.00
Wisconsin	30.00	253.00

Although Wisconsin heads the list in per capita value of her manufactures, she falls far behind Illinois and Ohio in the total value of manufactured articles. In this regard Illinois ranks third among the states of the Union.

CITIES

Cleveland, one of the most important of the lake ports, is situated at the mouth of the Cuyahoga River. It is built upon three plains or terraces rising one above another. Its location is a favorable meeting place for the coal of its own and the adjacent states of West Virginia and Pennsylvania with the iron from Minnesota and Wisconsin. This has led to the manufacture of iron and steel goods of all kinds and to shipbuilding. Owing to the increase in the length of lake vessels, the river is less advantageous as an anchoring ground than it formerly was.

The opening of the Erie Canal gave an impetus to the growth of Cleveland. The Ohio and Erie Canal, which connected it with Portsmouth, was another great advantage. Lake Erie furnishes an inexhaustible supply of good water and large quantities of fresh fish.

The city derives power from the "Great Falls" of the Cuyahoga River. In addition to ships, it manufactures machinery for unloading vessels, steel rails, tools, general hardware and automobiles. In 1920 its population was about 800,000.

Cincinnati is an important river port. It is the southern terminus of the Miami Canal, which connected Cincinnati with Toledo, and which was formerly important. Cincinnati does much business by means of the Ohio River. Coal, lumber, salt and clay are brought to the city by this route. The city is quite a railroad center. It has tanneries and manufactures wagons, carriages and furniture because hardwood is available. The presence of good pottery clay has led to the manufacture of the famous Rookwood pottery. The packing of meat, the manufacture of men's clothing and boots and shoes are important. Cincinnati draws considerable business from Kentucky and Indiana. In 1920 she had a population of approximately 400,000.

Toledo has an important position but a few miles from the shore of Lake Erie on the Maumee River. It has a good harbor and receives iron, lumber and grain from the west and coal from the east. It manufactures railroad cars, automobiles, machinery, glass and furniture.

Columbus, the capital, occupies a very central position. It has foundry and machine shops, and manufactures boots and shoes and

FIG. 167.—Euclid avenue, Cleveland's busiest street.

wagons and carriages. It is an important railroad center, and had, in 1920, a population of about 237,000.

Indianapolis occupies a central position in the state of which it is the capital. A net of railroads radiates in every direction from the city. Cattle from the surrounding country are here converted

MAP OF EAST CENTRAL STATES

into meat, and wheat into flour. As the city is located in the corn belt, much corn is handled. Indiana produces a great deal of coal and Indianapolis controls the trade in this mineral.

One of the results of the extensive development of agriculture in the state is the manufacture in the city of farm machinery and tools as well as wagons. The accessibility of hard wood has led to the manufacture of furniture. Other industries of importance are the making of structural iron, woolen goods and automobiles. The population in 1920 was, in round numbers, 314,000.

Gary, a city which has come into existence as if by magic, is to be Indiana's great lake port. Where now the city stands there was, in 1906, nothing but shifting sand dunes. A place was needed where steel could be more economically made than in Chicago or Pittsburgh, and so Gary came into existence. The United States Steel Corporation founded and owns the city. There was no natural harbor, but a breakwater was built and a canal and turning-basin constructed. Here Lake Superior iron meets coal from Illinois and limestone from both east and west, while coke is manufactured at the plant. A new channel was dug for the Calumet River and it was turned into it. A tunnel was dug out under the lake to supply water. In many respects this is the most wonderful city in our country. It has all modern conveniences, and had, in 1920, a population of 56,378.

Detroit, on the river of the same name, is the most important city in Michigan. A large part of the commerce of the Great Lakes of necessity passes through this city. It is situated where several lines of railroad cross the boundary between the United States and Canada. The river is about one-half mile in width and from 30 to 50 feet deep. Trains are ferried across and a double terminal of steel and concrete connects Detroit with Windsor, Canada.

Michigan leads in the manufacture of automobiles, and Detroit is her chief center for the manufacture of these vehicles. Cheap steel, coal and hardwood and nearness to the great centers of population are favoring conditions. In addition to automobiles, the city manufactures cars, machinery, cash registers and tobacco.

Grand Rapids, the second city in population, is the chief furniture manufacturing center in the United States. Accessibility to pine and hardwood led to the establishment of the industry, and the impetus thus obtained enables the city to maintain its place.

Chicago.—In 1673 two French missionaries, Joliet and Marquette, discovered the Indian village where Chicago now stands. They were probably the first white men to reach the spot. In 1803 the government built Fort Dearborn, and in 1833 the town had a population of 150. In 1837 Chicago was incorporated, having a population of 4,170. Although the city was in large part destroyed by the great fire of October, 1871, the federal census of 1920 showed that there were within the limits of Chicago about 2,700,000 persons. In a century Chicago has grown from an insignificant trading post to be

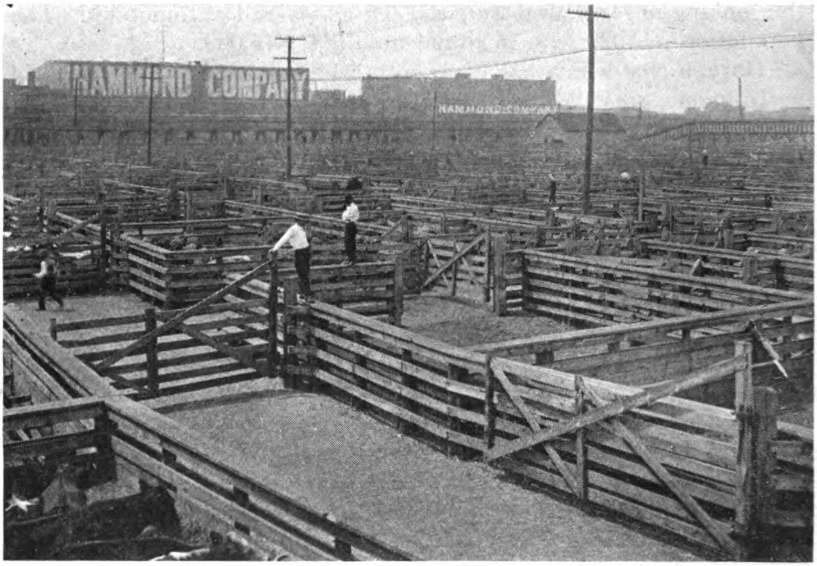

FIG. 168.—Chicago Stock Yard.

the second city in population in the United States and the fourth in the world.

The Chicago River and the harbor at its mouth, the almost imperceptible divide between the St. Lawrence and the Mississippi drainage and the fact that the east to west railroads were obliged to round the southern end of Lake Michigan, made it inevitable that a great city should grow up where Chicago stands.

As we have seen, Chicago has the great advantage of cheap transportation in securing and reshipping lumber, iron, copper, wheat and coal. She has an unlimited supply of pure water for domestic purposes and area for the expansion of the city.

In 1848 the Illinois and Michigan Canal was completed. This followed the Chicago River to the Desplaines and continued down the valley of this river to La Salle on the Illinois, a distance of 90 miles from Chicago. The canal was of great benefit to Chicago and the tributary country. Grain, potatoes, stone and dressed meats were shipped from Chicago, and lumber, groceries, agricultural implements and hardware were sent to the small towns along the canal.

Previous to the opening of the canal, lumber had been very high in price in the Illinois valley, as it had to be hauled from Chicago by wagon. The decrease in price which followed water transportation did much for the development of the valley. On April 23, 1848, a boatload of sugar reached Chicago from New Orleans by way of the canal. In 1853 the Chicago, Rock Island and Pacific Railroad was constructed parallel to the canal, and this led to a rapid decline in its business.

As Chicago developed, a canal of sufficient capacity to carry southward the sewage of the city became a necessity. Accordingly, the Chicago Sanitary and Ship Canal was constructed. This parallels the old canal, but is deeper and wider. Powerful engines pump the water of the Chicago River into the canal, whence it flows southward, finding its way to the Mississippi. When the Illinois and the Mississippi Rivers have been deepened, the canal will serve as a ship canal.

Chicago ranks second among the cities of the United States as a manufacturing center. First in value of products is the meat-packing industry. The city is on the edge of the corn and hog belt, and therefore is a natural market for hogs. Large numbers of cattle are taken into the corn belt from points farther west and there corn-fed for a time before being marketed.

Cheap transportation and the rapidly growing population of Chicago, and the large area for which it is the natural distributing center, have caused the city to become a great lumber market. The demand for agricultural implements in the prairie states, and the ease with which Chicago can provide the steel and wood which enter into their construction, have given the city first rank in the manufacture of these articles. In 1909 she manufactured 39 per cent. of the total output of our country.

Chicago is noted for the manufacture of cars, machinery, general hardware, men's clothing, furniture and refrigerators, bakery goods, and for the printing and publishing business.

Milwaukee.—Lake Michigan and Lake Superior have determined the location of most of the important cities of Wisconsin. Chief among these is Milwaukee. The primary factor in determining the location of the city was the bay at the mouth of the Milwaukee River. Here was a large area of protected anchorage due to a sand bar and having a depth inside the entrance of 12 feet or more. These natural conditions have been improved by the expenditure of much money. On the average the harbor is ice bound only 14 days each year.

The Menominee River, a small stream, enters the city from the northwest and joins with the Milwaukee River, which furnishes some power. The lake supplies water by means of an intake which extends under the soft shale three-fourths of a mile from shore.

An abundance of hemlock bark and hides obtained in the city, as well as in Chicago, has resulted in giving Milwaukee first rank in the tanning industry. Milwaukee is the chief barley market in the United States. Flour milling is another industry of considerable importance.

The city is the chief manufacturing center in Wisconsin, producing in 1910 more than one-third, by value, of the manufactures of the state. According to the census of 1920, it had a population of 457,147, and was the only city in the state having more than 100,000 inhabitants.

Of all the freight entering Milwaukee by rail, nearly one-third was, in 1910, in the form of grain. The city is a great coal market. Nearly all of this commodity is received by water. About one-half of it is used locally and the remainder is shipped to various points within and without the state.

Superior, although not a large city, ranks among the great ports of the world in *tonnage*, although not in value of commodities handled. It is at one of the termini of the greatest inland waterways in the world, is in a region rich in wheat, lumber and iron, and has a magnificent land-locked harbor. The St. Louis River empties into the harbor and the city extends up the river for many miles.

Great quantities of coal are shipped by water from Pennsylvania, West Virginia and Ohio to Superior, from which point it is shipped by rail to a large tributary area in which there are no coal deposits. As the harbor is closed by ice from three to four months of the year, much coal is of necessity stored in the city. Immense amounts of iron are shipped from Superior to supply the iron and steel plants in Chicago, Gary, Pittsburgh and other points. Wheat from Canada, Minnesota and the Dakotas is another important item in the eastward moving freight. Manufacturing is aided by power developed from the St. Louis River. Among the manufactures are flour, linseed oil, engines, wind-mills and chairs.

STUDIES

How has topography influenced the development of these states? What principles in physical geography are brought out by a study of the climate of the province? In what part is there most water power? Which of the states in the province has the most valuable natural resources? Why is agriculture so highly developed? Write a short paper showing all of the ways in which the Great Lakes influence the geography of the province. Why is Chicago the most important city?

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CHAPTER XLIV

THE WEST CENTRAL STATES.

General Statement.—The states which are treated in this chapter are Minnesota, Iowa, Missouri, the Dakotas, Nebraska and Kansas. Physiographically, a part of the area lies in the Prairie Plains and a part in the High Plains provinces. In general it is a region of low relief. Nearly the entire area belongs to the Mississippi drainage.

The population of the area is rather sparse. Missouri has the greatest density, 49 per square mile in 1920. In South Dakota in the same year the density was but 8 per square mile, and in North Dakota the same. Generally speaking, the density decreases from east to west owing to the decrease in the mean annual precipitation.

Surface Features.—In traveling from the Mississippi River westward one is scarcely conscious of the ascent, so gradual is it, yet when the western margin of the High Plains has been reached the traveler is higher than are most of the peaks in the Appalachian Mountains.

In only a few places is the monotony of the surface features broken by an uplift. One of these is the Height of Land which extends in a general east-west direction partly across northern Minnesota. It is a mountain range eroded nearly to its base and composed of ancient, crystalline rocks. The Mississippi rises on the south slope of this uplift. In the part known as the Mesaba Range much iron is mined.

In southwestern South Dakota and in eastern Wyoming there is an early circular uplift covering some 6,000 square miles. Viewed from the practically treeless plains by which it is surrounded, it presents a blue-black appearance due to the timber upon it, and hence the name *Black Hills*.

Most of the uplift rises about 2,000 feet above the general level of the plains. The highest peak, Mt. Harney, is 7,216 feet above the sea. The precipitation is greatest upon the highest parts, and here there is most timber.

The central part of the uplift is composed of resistant slates, schists and granites, while surrounding it are sedimentary rocks, for the area came into existence as an island. The sandstones and shales dip outward from the core. Upon the softer formations valleys have developed, while the harder ones stand up as ridges. One of the concentric valleys thus developed is Red Valley, so named because of its red sandstones. The outer rim of the valley rises steeply from 300 to 400 feet, and is caused by resistant sandstones and shales. Streams flow outward in all directions from the common center, most of them uniting with the north and south forks of the Cheyenne River

Owing to their mineral wealth, the Black Hills are much more densely populated than they otherwise would be. Gold and lead are produced in considerable quantities.

A third uplift is found in southern Missouri, northern Arkansas and eastern Oklahoma, the *Ozark Uplift.* It is a very ancient region geologically and covers an area of about 75,000 square miles. The highest peaks, which are only about 2,000 feet in altitude, are found in the Iron Mountain region.

As in the Black Hills, there is some timber in the Ozark Mountains, and their ancient crystalline rocks contain iron, lead, zinc and coal. Because of their mineral wealth, several towns have grown up; among them, Joplin and Carthage.

The plains of which these states form a part extend from Mexico northward to Canada. Iowa belongs to the Prairie Plains. The levelness of the land throughout most of the region under consideration is favorable to agriculture, especially to the growing of grain, and to the construction of wagon and railroads. It also permits a very high percentage of the precipitation to penetrate the soil.

In west central Nebraska there is an extensive area known as the Sand Hills. In many cases the depressions between the sand dunes contain lakes or ponds. In some the water is fresh and in others brackish. This part of the state is sparsely populated.

South and west of the Black Hills are the Bad Lands. This formation extends across the state line into northwestern Nebraska. Generally speaking, they lie between the South Fork of the Cheyenne and the Niobrara River. They are composed of unconsolidated clays and soft sandstones. Occasional layers of harder material stand up as ridges. The region is wonderfully rich in fossil forms of mammals, and various educational institutions have here obtained valuable collections.

Hydrography.—Owing to the navigability of the Mississippi and the Missouri Rivers, they were, before the days of railroads, of great value to these states. In its course of 2,553 miles the Mississippi falls but 1,535 feet. According to Darton,[1] the average daily discharge

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[1]Journal of Geography, vol. iii, p. 257.

of the river is more than 50,000,000,000 cubic feet. It is navigable for boats of very light draft as far as St. Paul, and for larger boats to St. Louis.

The Missouri has a total fall of 12,000 feet, and is consequently a much swifter stream than the Mississippi. Trappers and traders used it extensively in the early days, however. The Platte, Arkansas, the Kansas and the many smaller streams are of little or no value from the standpoint of navigation. The Platte is shallow and shifts its course. Owing to the slight precipitation, many of the streams have little volume except immediately following rains or when the snows in the mountains are melting.

Although irrigation is practiced to some extent in the western part of this region, the streams are not as valuable as sources of water supply as they would be did they not in so many cases flow in trenched valleys. In the past the trails followed the larger valleys not only because they were the easiest routes of travel, but also because they furnished water for the people and the stock, and because the trees which grew in the river bottoms furnished fuel. Railroads follow the valleys in many cases today. This is in part because of ease in road building and in part because settlements had sprung up along them, thus creating a demand for transportation facilities.

Water power has been developed in this region in comparatively few places. The Falls of St. Anthony furnish much power used in sawing timber and particularly in grinding wheat in Minneapolis.

At Keokuk, Iowa, are the Des Moines Rapids. At great cost the government has constructed a concrete dam nearly a mile in length spanning the river at this point. The dam has created deep water for a distance of 60 miles up stream, and 300,000 horse-power can be developed.

It is impossible to tell just what this will mean to the manufacturing industries of the central part of the United States. The saving in coal will be enormous. St. Louis, although 137 miles south of Keokuk, has contracted for 60,000 horse-power for a period of 99 years. Power will be used in several smaller cities nearer to Keokuk. Outside of Minnesota this region has few lakes, although there are some in the eastern part of South Dakota and in Iowa.

Influence of Climate.—Because of the central position of the region, its climate is very continental. Owing to the considerable range in latitude, the winters are much more severe in the northern than in the southern part. Blizzards sweep across the level stretches of land, delaying travel and communication and causing loss among

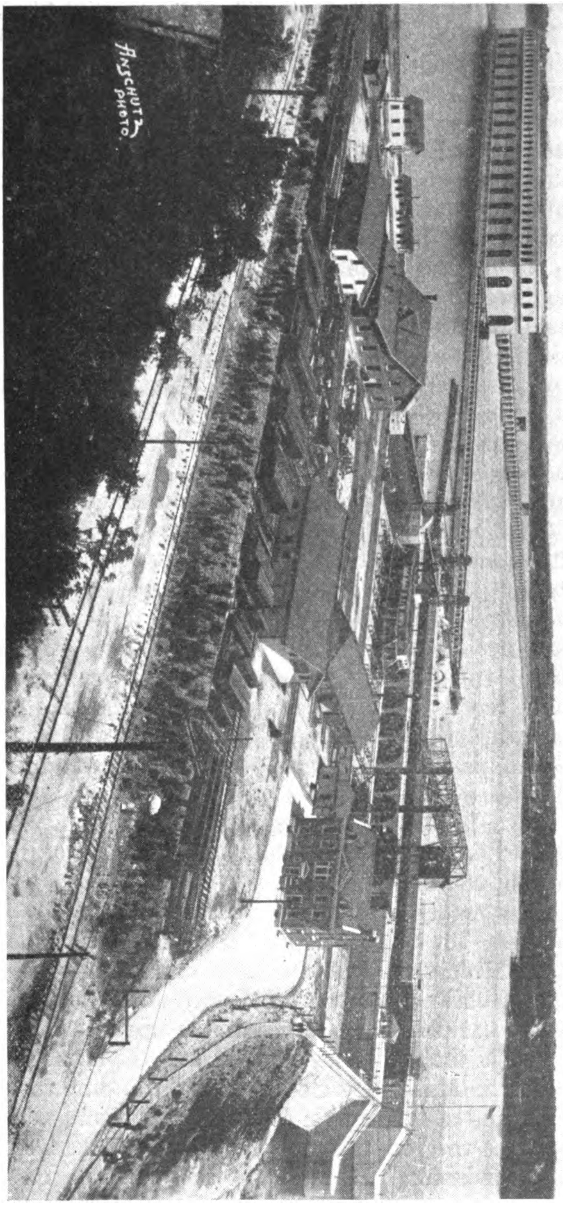

Photo by H. M. Anschutz.

FIG. 169.—The Keokuk project.

live stock. As is shown by the map, the precipitation gradually decreases from the east to the west. West of the one hundredth meridian it is in most sections less than 20 inches annually, and therefore not sufficient for agriculture. The Rocky Mountains deprive this semi-arid belt of much moisture.

Agriculture and Stock Raising.—These are essentially agricultural states. The soil is fertile, much of it being glacial till. In some sections, as in southeastern Nebraska, there are large areas of loess. The area in farms varies from 53 per cent. in South Dakota to 95 per cent. in Iowa. In only two counties in Iowa, Dickinson and Emmet, was the percentage in farms in 1910 less than 90. The percentage of the population classed as rural in 1910 varied from 57 in Missouri to 92 in South Dakota.

As a result of studies made in the Black Hills, Professor N. H. Darton, of the United States Geological Survey, was able to predict with remarkable accuracy the depth at which water following the dip of the strata eastward from this section would be tapped by wells in South Dakota. One well put down by the Burlington Railroad has a depth of 2,695 feet and has a flow of about 500,000 gallons daily. Many other artesian wells are proving of great value.

In Minnesota and the Dakotas the most valuable crop is wheat. The Red River Valley, which is almost level, is a wonderful wheat country. In the other states in the group corn is the leading crop. In the chief corn-growing states the hog industry is very important. In all of the states hay is a prominent crop. In southern Kansas some cotton is grown and there is considerable fruit.

In the semi-arid part of the region cattle are raised in large numbers. The light snowfall and the nutritious bunch grass are favorable conditions. Windmills are of great value on many ranches, making it possible to have a plentiful supply of water for the stock. Many cattle are shipped into the eastern part of the region to be fed on corn for a few weeks before being marketed.

Forest Resource.—This whole region has only one important forest belt, that in Minnesota. As has been stated, there is some timber in the Black Hills and in the Ozark Uplift. They supply little beyond the purely local demand which is made upon them by the mines and the towns in the areas, however. Along the river bottoms there is some timber, and many trees have been planted by the farmers. Although the absence of timber favored agriculture, it was a disadvantage so far as the construction of buildings and fences and a fuel supply were concerned. Many of the early settlers built sod houses, and when railroad facilities were poor, corn was often used as a fuel.

Mineral Wealth.—Minnesota is exceedingly rich in iron, producing about 75 per cent. of the total output of the United States. The iron-producing land is largely in the hands of the state, and the money obtained from leasing it is devoted to educational purposes. This is making the University of Minnesota one of the greatest in our country.

In the Dakotas there are vast deposits of lignite which until recently were thought to be practically worthless. South Dakota has gold and lead. Kansas is one of the leading salt-producing states in the Union, Hutchinson being the chief center. By means of pipes, water is carried to the salt, which after it has been dissolved, is pumped up as brine. In the Ozark Uplift there are iron, lead, zinc and cobalt. Valuable clay deposits are worked in and near St. Louis and Kansas City.

Manufactures.—The states in this group are not important in manufacturing, yet manufacturing is steadily increasing. The per capita value of the manufactured articles in the several states in 1909 was as follows: Minnesota, $197.00; Iowa, $117.00; Missouri, $174.00; North Dakota, $33.00; South Dakota, $30.00; Nebraska, $167.00; Kansas, $192.00. For the same date the figures for New York are $370.00, Pennsylvania $334.00, and Illinois $340.38. The percentage of the total population engaged in manufacturing pursuits varied from 4.6 in Missouri to practically 1.0 in South Dakota. It will be observed that the states in which there are no large cities rank low in manufacturing.

Railroads.—The railroad net is well developed about as far west as the one hundredth meridian. The decreased precipitation west of this has resulted in a sparse population, and therefore there is not a great demand for transportation facilities. The region is served by several transcontinental lines with spurs into the sections offering the most trade.

CITIES

St. Louis is the greatest city in the area, and in 1910 ranked fourth among the cities of the United States in manufacturing. The selection of the site and the development of the city illustrate the importance of geographic conditions. Wishing to establish a trading post which would control the Missouri and the Mississippi, the Louisiana Fur Company in 1764 sent Pierre Liqueste Laclede to select a site.

Before the selection was made Laclede learned that France had ceded to England the land east of the Mississippi. The new post was therefore of necessity located on the west side of the river. Twenty miles south of the junction of the Missouri and the Mississippi there are limestone terraces about 2 miles in length. The lowest of these is about 20 feet above the river and out of the reach of floods. A small stream called Mill Creek flowed into the river at this point, and there were springs also. Here the post was established.

FIG. 170.—The Olive street canyon, St. Louis.

Until about 1840 the fur trade was the chief activity in St. Louis. Down both of the great rivers many boatloads of furs were floated each year, and the trappers secured supplies from St. Louis. About 1822 trade with Santa Fé began, and developed rapidly. St. Louis, because of its position, profited greatly from this for many years. In 1817 the first steamboat reached the city. "The influence of the river trade on the growth of St. Louis is suggested by the fact that in 1845 there were 2,050 steamboat arrivals in the city. The first steamboat to visit St. Louis was the *General Pike*, in 1817. Prior to this it had cost 50 cents a pound to pole or row freight from New

Orleans to St. Louis; twenty years later the freight rate for the same trip was 2 cents a pound."[2]

Today St. Louis profits by the fact that the minimum depth of the river below the city is 9 feet, while above it is from 3 to 5 feet. St. Louis therefore became a point of reshipment. Much lumber is received from the north by water and some coal from the east by way of the Ohio and Mississippi. At this point there are several bridges over the river, connecting the city with East St. Louis. One of these, a municipal bridge costing about $5,000,000, was opened to traffic on January 19, 1917. In yet another way the Mississippi is of value to the city. It furnishes a water supply which is rendered clear and soft by a process of filtration.

St. Louis has become one of our greatest railroad centers. The bridging of the river is one of the several causes of this. There are coal, iron, lead and zinc in the Ozarks, and hardwood, which the Ohio and the Mississippi make available. The second point has led to the manufacture of furniture, cars and wooden ware.

Being in the hog and corn belt, having an abundant water supply and excellent facilities for shipment, St. Louis has become one of our greatest slaughtering and meat-packing centers. This is by far the most important industry in the city. Great numbers of hides being at hand and tanbark obtainable by water, boots and shoes are manufactured extensively. This was the second industry in importance in 1909.

The manufacture of tobacco ranks third in value. Again a geographic condition is responsible, for the Ohio and Mississippi afford cheap shipment for the raw products. There are large deposits of clay close at hand, and this has led to the manufacture of bricks, tile and sewer pipe. The limestone which underlies the city and vicinity is quarried and used in the manufacture of Portland cement. Other important manufactures are machinery, general hardware, drugs, chemicals, soap and baking powder.

St. Louis is the chief city in the metropolitan district, which includes East St. Louis and several smaller places in Illinois. These towns now carry on considerable manufacturing as a result of the completion of the Eads Bridge in 1874. Previous to this date ferry-boats carried both passengers and freight across the river, as there was no bridge. This was a slow process, and at times during the winter floating ice temporarily tied up traffic.

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[2] Fenneman, N. M.: "Physiography of the St. Louis Area," p. 70.

Kansas City, Missouri, is located where formerly there was a French fur-trading settlement. Until 1866, when a railroad first served the region, Kansas City was important in the caravan trade carried on over the Santa Fé trail.

FIG. 171.—A scene in Kansas City.

The city is located at the confluence of the Kansas and the Missouri Rivers and at a point where the Missouri makes a great bend to the northward. In early days much westward travel followed the Missouri to this bend and there left the river. Naturally a town of importance developed there.

There are three levels upon which the city is built, the lowest being devoted to the railroads and stockyards, to manufacturing and the wholesale trade, the middle to the retail business, and the highest to residential purposes.

The great agricultural wealth of the area tributary to Kansas City and the extensive development of stock raising have resulted in making the city an important railroad center and a grain and stock market. The city has instituted a line of freight boats upon the river, and the government has made some appropriations for improving navigation. Meat packing is an important industry. There are flour and grist mills, and much lumber is handled. In 1920 the population was about 324,000.

Topeka, the capital of Kansas, is located in a fertile prairie region on both banks of the Kansas River about 65 miles west of Kansas City. In addition to agricultural interests, the tributary country supports coal mining and stone quarrying. The city has large railroad shops, and foundries, flour mills and ice plants. The population in 1920 was about 50,000.

Omaha.—The map shows that practically all of the population of Nebraska is in the eastern half of the state. There is no city having a population of 10,000 west of the hundredth meridian. In 1920 Omaha, the largest city, had approximately 191,000 inhabitants. Its chief industry is the smelting and refining of lead. It is quite an important railroad center. South Omaha, which is practically a part of the larger city, is the leading manufacturing center of the state. Its interests are almost entirely connected with the slaughtering and meat-packing industries.

Iowa has no city of 100,000 inhabitants. Des Moines, the capital and largest city, has a central situation on the river of the same name. It manufactures foundry and machine-shop products and packs meat. Both Sioux City and Cedar Rapids excel the capital in the value of their manufactured products. Meat packing is the leading industry in Sioux City.

In the Dakotas, as in Kansas and Nebraska, the larger cities are in the eastern halves of the states. Sioux Falls, on the falls of the Big Sioux River, and Aberdeen, Huron and Mitchell, all in the fertile James valley, are the largest cities in South Dakota.

The two largest cities in North Dakota, Fargo and Grand Forks, are in the remarkably productive Red River valley. Fargo is quite a railroad center, and much wheat is shipped to Duluth, Minneapolis and other points. It manufactures saddlery and harness for the ranchers in the tributary country. Grand Forks manufactures flour.

St. Paul.—The most northerly of the many important cities on the Mississippi River are St. Paul and Minneapolis. The Falls of St. Anthony are caused by a ledge of resistant limestone, a few miles north of the junction of the Minnesota and the Mississippi. At the head of navigation a trading post naturally developed. To this post great quantities of furs were brought. The fur-trading center has developed into the magnificent city of St. Paul.

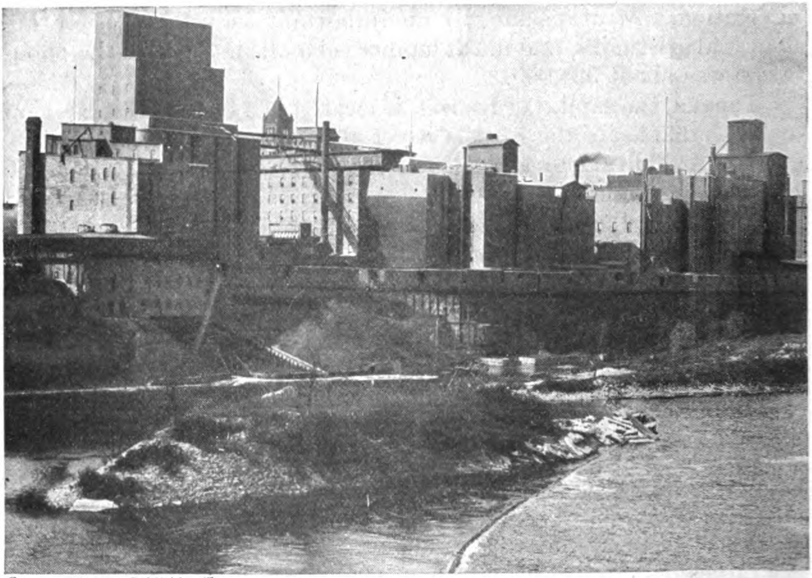

FIG. 172.—Flour mills in Minneapolis.

As a result of its early prominence St. Paul is yet one of our chief fur centers, and fur goods are among the important manufactures. When settlers were pouring into Minnesota and the Dakotas to engage in wheat growing, great numbers went as far as St. Paul by water. The city is an important center of distribution and one of our great railroad centers.

The foundry and machine-shop products are more valuable than any other of her manufactures. The making of boots and shoes is another important industry.

Minneapolis is the larger of the Twin Cities, and is the chief industrial center in the state. It has the great advantage of cheap

MAP OF THE WEST CENTRAL STATES

power obtained from the Falls of St. Anthony and from Taylor's Falls in the St. Croix River. This is utilized in sawing lumber obtained in the nearby forests and in grinding the wheat produced in the tributary country.

The city began as a lumber center, and lumber and the commodities derived from this source are today among her most valuable products. Minneapolis is the chief flour milling center in the United States. Wheat from the Red River valley and from other parts in

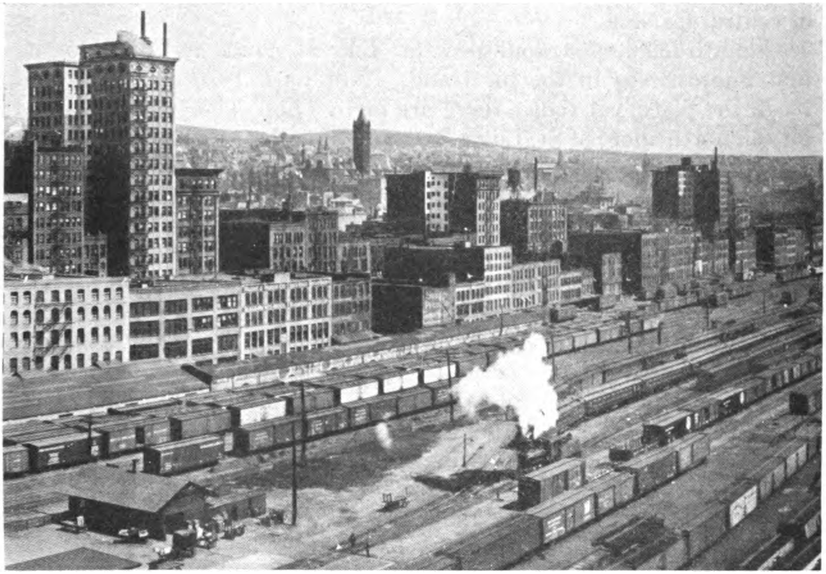

FIG. 173.—A scene in Duluth.

the Northwest pour by rail into the city. Here are located more than 20 great flour mills, and many elevators in which wheat is stored. Linseed oil is manufactured in large quantities, for Minnesota is one of our chief flax-producing states. There are many foundries, machine shops and railroad repair shops. It is interesting to note the influence of the course of the river upon the growth of these cities. Because of this, Minneapolis has her greatest extent from north to south and St. Paul from east to west.

Duluth.—At the head of the greatest inland water route in the world stands Duluth. Here systems of transportation change. From the forests of Minnesota come trainloads of lumber to be placed upon ships and carried to the lake ports farther south and east. The Mesaba Range supplies great quantities of iron ore which are shipped to the iron and steel centers—Chicago, Gary, Cleveland, Buffalo, and even Pittsburgh. Each autumn the railroads rush wheat from Minnesota and the Dakotas to Duluth to be shipped eastward before the season of navigation closes. The chief item of freight which the lake steamers carry back to Duluth is coal, for the northern part of the Mississippi valley has little of this very important commodity. Duluth distributes coal over a large area, including a part of central Canada.

Duluth has had a rapid growth. Like St. Louis and St. Paul, its first interest was in the fur trade. Not until 1870 did a railroad reach the place, yet today there are many lines. The city is situated on the north shore of St. Louis Bay, and directly across the bay—that is, to the southeast—is Superior. Minnesota Point, a long narrow bar of sand, extends from the northern shore southeastward for about 7 miles, and Wisconsin Point projects from the southern shore northwestward for about one-half this distance. These peninsulas nearly enclose the bay, which is thus well protected. In order to avoid sailing around the end of Minnesota Point in entering or leaving the city, a ship canal was cut across the base of the point. This has promoted growth.

The city has a beautiful situation. For about 30 miles it stretches along the shore of the bay, being built upon hillsides that overlook the water. The harbor affords anchorage to the largest lake vessels. The cost of shipping a bushel of wheat from Duluth to Buffalo by water is approximately one-fourth as great as the cost of shipping a bushel of wheat between the two points by rail. Thus cheap transportation is one of the great advantages possessed by Duluth.

The city has industrial as well as commercial advantages. The St. Louis River, which enters the bay from the southwest, has been utilized in the development of power. By means of a canal, water has been led from a reservoir fed by a series of rapids, across uplands to a point where a head of 375 feet is obtained. A large amount of power has been developed, and is used in both Duluth and Superior.

STUDIES

To what extent does the topography of these states guide road building and the distribution of population? Why is the Missouri more subject to flood than is the Mississippi? What commodities are shipped by river? Why is a part of the area subject to tornadoes? Why is much of the section well adapted to fruit growing? Why can the iron of Minnesota be so advantageously handled? What advantages has St. Louis for manufacturing; for commerce? Why is Duluth important as a coal distributor?

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CHAPTER XLV

The Rocky Mountain and Great Basin Provinces.

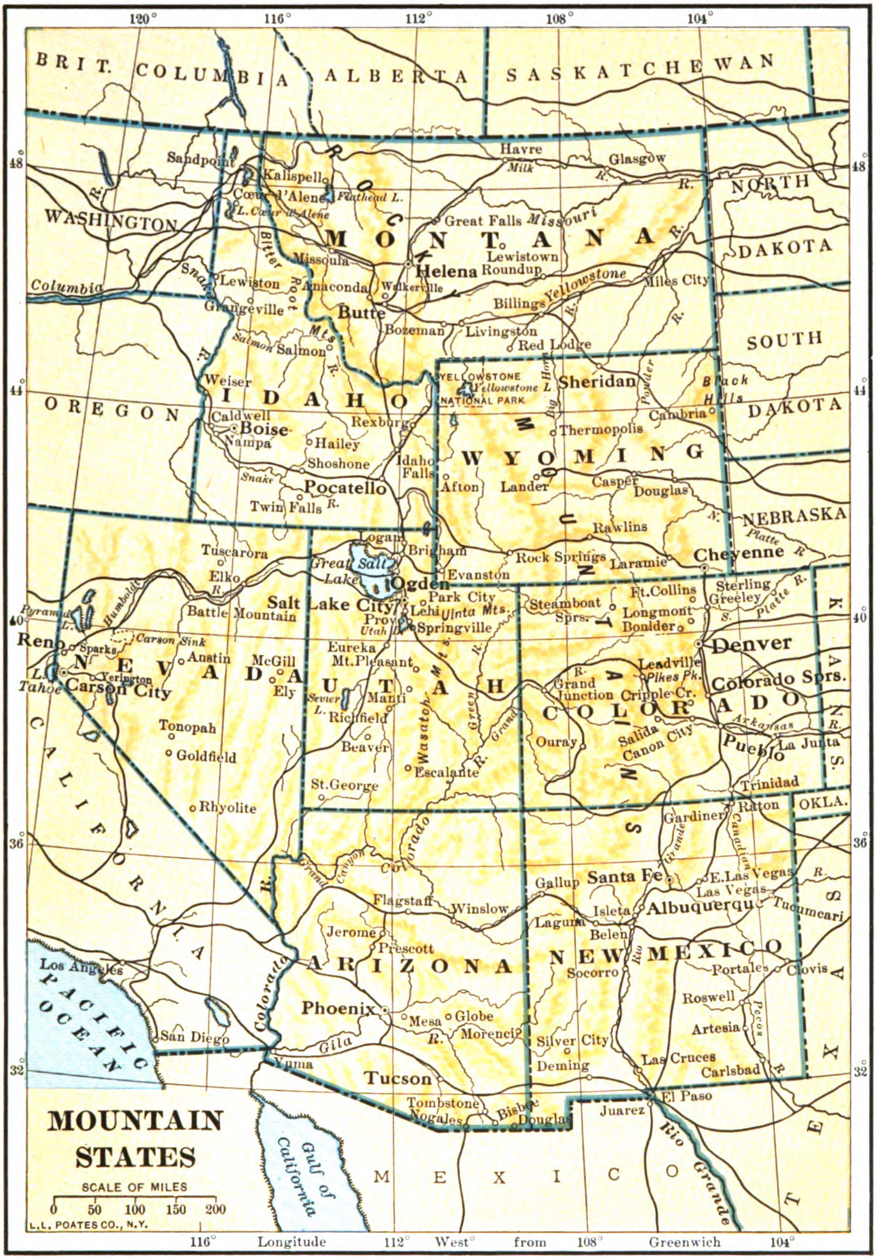
General Statement.—It is exceedingly interesting to examine a geography, such as Morse's, edition of 1807, and find that not a state in the vast area included under this chapter heading is mentioned. They are not mentioned because at that time they did not exist. There was no territorial organization previous to 1861, and Nevada, the first territory to become a state, was admitted in 1864.

In 1805 Captains Lewis and Clark explored parts of Montana and northern Idaho while in their memorable trip. They left St. Louis in May, 1804, and returned in September, 1806. Practically nothing was known concerning the great Northwest previous to their expedition.

The Rocky Mountain States have today many thriving cities with every modern convenience. They have several transcontinental lines of railroads. They have good educational facilities. Considering the vast extent of territory, the population is very small, however. The area of these states amounts to 28 per cent. of the total area of the United States, but their population was in 1920 only about 4 per cent. of that of the United States. During the decade ending in 1920 the population of the group increased 21 per cent. The lack of cheap agricultural land east of the Rocky Mountains, the development of irrigation in the Rocky Mountain province, the vast mineral resource and the extension of roads are the chief causes for the greater increase in this province than in the United States as a whole.

Influence of Topography.—This area is very mountainous. The numerous ranges of the Rocky Mountain System, the Wasatch Mountains, the Uintas, the Basin ranges and other less important elevations diversify the surface. Between the Rocky Mountains on the east and the Sierra Nevada and Cascade Mountains on the west are vast plateaus, the averge elevation of which is from 4,000 to 8,000 feet.

Before the days of railroads the mountains were a formidable barrier to travel and settlement, and today they cause the construction of roads to be costly and necessitate a large charge for transportation. The early western trails followed the valleys and sought out the lowest passes, and the railroads in a general way follow these routes. The valleys of the Missouri, Yellowstone, Platte, Arkansas, Rio Grande, Grand, Gunnison, Snake, Humboldt and other streams



MAP OF ROCKY MOUNTAIN AND PLATEAU STATES

are occupied by lines of railroad. The Colorado is an important exception. No railroad parallels the river and none crosses it north of the Needles, where the Santa Fé effects a crossing.

From the standpoint of scenery, the topography exerts a marked influence upon human conditions in the region. Colorado is a national playground. The Garden of the Gods and the many natural parks, with their trees, streams, lakes and desirable summer climate, are attracting large numbers of persons every summer. The Grand

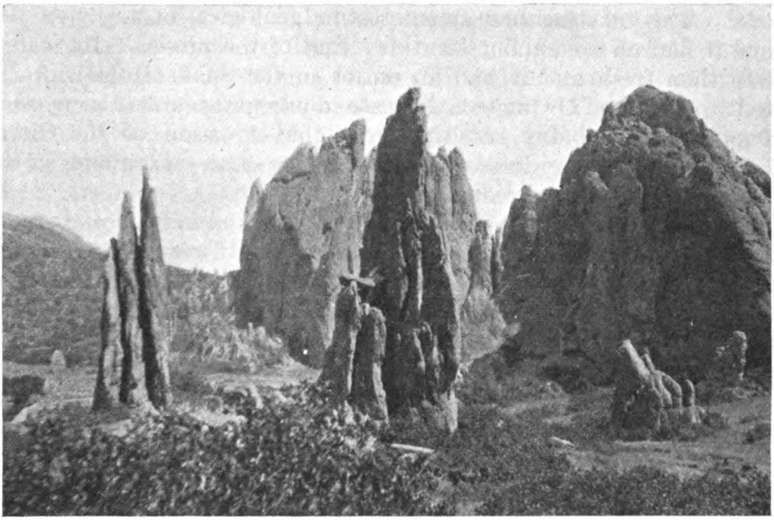


Photo by Chamberlain.

FIG. 174.—The Garden of the Gods, Colorado.

Canyon of the Colorado is one of the wonders of the world. Here, as the vast plateau has slowly been elevated, the river has cut down through the practically horizontal strata producing a canyon which is in places more than a mile in depth. So great an attraction is this that the Santa Fé has built a branch line from Williams, Arizona, to the rim of the canyon.

Yellowstone National Park, largely in the northwestern corner of Wyoming, is especially noted for its many geysers and hot springs. Thousands of people visit this wonderland every summer.

Glacier National Park, in the northern part of Montana, is just becoming known. It has many glaciers, lakes, streams, forests and mountains.

Hydrography.—The rivers have steep gradients and therefore flow swiftly. In most cases they have eroded deep canyons. Practically speaking, there are no navigable streams within the area, although the lower Colorado is used for a short distance.

Many of the streams furnish water for irrigation, but others flow in such deep canyons that they are of no value from this point of view. Much power can be developed from the rivers, and considerable development has already taken place.

There is but one large body of water in the province—Great Salt Lake. This lake has had an interesting geological history. At one time it had an area about ten times that of the present. Its waters were then fresh and it had an outlet to the Snake River through Red Rock Pass. Owing to a decrease in precipitation and increase in evaporation, probably resulting from the elevation of the Sierra Nevada, the volume decreased until there was no outlet, and so the waters in time became salty.

Owing to seasonal changes in temperature and in rate of evaporation, the lake level oscillates semi-annually. The average annual range amounts to about 16 inches. There are also changes in level due to variations in the annual precipitation. For example, the lake level in 1914 was 6 feet above the level of 1905.

The density of the water is now so great, there being about 20 per cent. of salt, that a human being can not sink in it. On the shore there are several resorts, chief of which is Saltaire. Large quantities of salt are produced by evaporating the lake water.

South of Great Salt Lake, and connected with it by the Jordan River, is Utah Lake. This body of water is fresh and has an area of 130 square miles. The lake was caused by a flow of lava that for a time dammed the Jordan River.

At high altitudes there are numerous glacial lakes, especially in the northern part of the area. Some of these are beginning to attract summer visitors because of their scenery and their fishing.

Influence of Climate.—Except in the extreme southern part the climate, owing to the influence of both latitude and altitude, is quite cold during the winter. Upon the mountains there is heavy snowfall, but it is light upon the plateaus. Blizzards occasionally obstruct travel and communication and cause loss to stock on the range.

In the south latitude and distance from the sea combine to produce high summer temperatures, and very moderate winter conditions exist upon the lowlands. In the basin of the Gila River oranges, dates and cotton are grown. In fact cotton is grown in southwestern Utah.

Except upon the mountains, rainfall is very light in the plateau section. This is because the western mountains cause precipitation upon their western slopes, thus depriving the plateau of moisture. The Great Basin, which comprises nearly all of Nevada, western Utah and a considerable area in eastern California, sends no stream to the sea.

The precipitation map makes it clear that desert conditions prevail in considerable areas. Knowledge of the region has caused a great shrinkage in the supposed area of the Great American Desert. Directly west of Great Salt Lake is an area about 100 x 40 miles in its dimensions which yet bears this name. This is a true desert.

Agriculture.—The tilling of the soil is greatly restricted by both surface conditions and lack of precipitation. There are sections where the soil contains so much alkali that few plants would grow in it, but for the most part all that is needed is water. Because of light precipitation, the soils have not been leached as they have in more humid regions. Although agriculture is not carried on upon an extensive scale, the development of irrigation is each year bringing larger areas under cultivation.

TABLE 55.

PER CENT. OF AREA OF ROCKY MOUNTAIN PROVINCE IN FARMS IN 1909.

Arizona	2
New Mexico	14
Utah	6
Colorado	20
Nevada	4
Idaho	10
Wyoming	13
Montana	14

In Colorado, Utah and Idaho sugar beets are grown in large quantities, and beet sugar is manufactured. Where there is sufficient water, alfalfa is an important crop. The region to the north of Denver is a great potato country, while in the vicinity of Grand Junction peaches, apples and cherries are successfully grown. Much fruit is grown in Utah valley, and there are canning establishments there.

A large number of the government reclamation projects are found in these states. Among them is the great Salt River Project, which serves an area of 210,000 acres, of which Phœnix is the center. In south-central New Mexico is the Rio Grande Project, which derives water from the Rio Grande. Nevada has the Truckee-Carson Project, Utah the Strawberry Valley Project, and in Colorado is the famous Uncompahgre Valley Project. In Idaho is the Boise Project, in Wyoming the Shoshone Project, and in Montana the Milk River, Blackfeet, Sun River and other projects.

Stock raising is one of the leading industries in these states. The high price of land east of the Rocky Mountains has steadily shifted the cattle ranges westward. In the more arid sections, stock does not always have sufficient water and pasturage and in the north some loss is caused by blizzards. The Chinook winds are a help to stockmen in the Northwest because these winds, being dry and warm, cause the snow to evaporate rapidly. Partly on this account stock can secure considerable food on the range during the winter months.

As sheep can find pasturage where cattle can not, these states are well adapted to sheep raising. In 1919 Wyoming led all the states in the Union in the number of sheep, while Idaho ranked second. Each state in the Rocky Mountain group had more than 1,000,000 sheep.

Vegetation.—Forests exist upon the mountains and the most lofty plateaus, but owing to the roughness of the country and the great distance from markets there is little lumbering. On the desert areas the vegetation is of such kinds as have become adapted to the scanty rainfall—the cactus is an example. Except in humid mountain valleys there is no sod.

Influence of Mineral Wealth.—The fur industry first attracted white men to this region, but later mineral wealth was the chief object. Gold, silver, copper and lead are produced in large quantities. Some coal is mined, and there are valuable deposits of iron not yet worked. Salt is produced in Utah. A large number of towns and cities owe their origin and their growth to mineral wealth. Cripple Creek, Leadville, Georgetown, Creede, Telluride and Silverton are among the Colorado towns. Denver owes its prosperity in large measure to the mining industry. Bisbee, Arizona, is a great copper center. Helena and Butte, Montana, are mining centers, and many others might be named.

Transportation.—In spite of the difficulties connected with the building of roads several transcontinental lines cross these states. The Santa Fé crosses southeastern Colorado, following the Arkansas for some distance. It strikes the Rio Grande a little southeast of the ancient city of Santa Fé. It follows the valley for a short distance and then pursues a nearly westerly course to Los Angeles. From El Paso the Southern Pacific extends across southern New Mexico and Arizona, crossing the Colorado River at Yuma.

The San Pedro, Los Angeles and Salt Lake connects Los Angeles with Salt Lake City. Here connections are made with the Denver and Rio Grande. The Union Pacific crosses southern Wyoming, taking advantage of the low plateau in the southeastern part of that state. The Northern Pacific, the Great Northern and Chicago, Milwaukee and St. Paul cross Montana and Idaho. Many branch lines serve the various sections of this province.

CITIES

Denver.—At the junction of Cherry Creek and the South Platte River some cabins were built in 1858. Here cottonwood trees afforded shade and firewood and the streams furnished water for domestic purposes and later for irrigation. At this point is located the largest of the Rocky Mountain cities—Denver.

The growth and prosperity of Denver are largely due to the great mineral wealth of Colorado. As mining increased in importance Denver more and more came to be the center from which supplies were obtained and to which ores were sent to be smelted. The first railroad reached the city in 1870, and Denver is now the chief railroad center of the Rocky Mountain region.

Coal is necessary for smelting, and Denver is so situated as to be able to obtain coal cheaply. As a result, lead and copper are shipped here to be smelted. The coal is one of the factors leading to the manufacture of mining machinery and tools, which are supplied to the mining centers in various parts of Colorado and in other states. Water power also aids in manufacturing.

To the north of Denver is a productive agricultural area in which the waters of the South Platte are used for irrigation. Potatoes and vegetables are grown in large quantities. In the city are mills where wheat is ground. Thus Denver furnishes the mining centers with food and also with meat which is packed in the city. Because of the importance of the industry of stock raising in Colorado, Denver manufactures butter, cheese and condensed milk.

No other large city in our country has so lofty a situation as Denver, being just about one mile above sea level. The atmosphere is remarkably clear and dry and the air is pure and invigorating. Pike's Peak, nearly 100 miles distant, may be seen on clear days.

The percentage of sunshine is very high and the mean annual precipitation is about 15 inches. These conditions, together with the wonderful scenery near at hand, have caused Denver to become a great health and pleasure resort.

Salt Lake City.—In July, 1847, a settlement was established where Salt Lake City now stands. It is in the midst of a wilderness

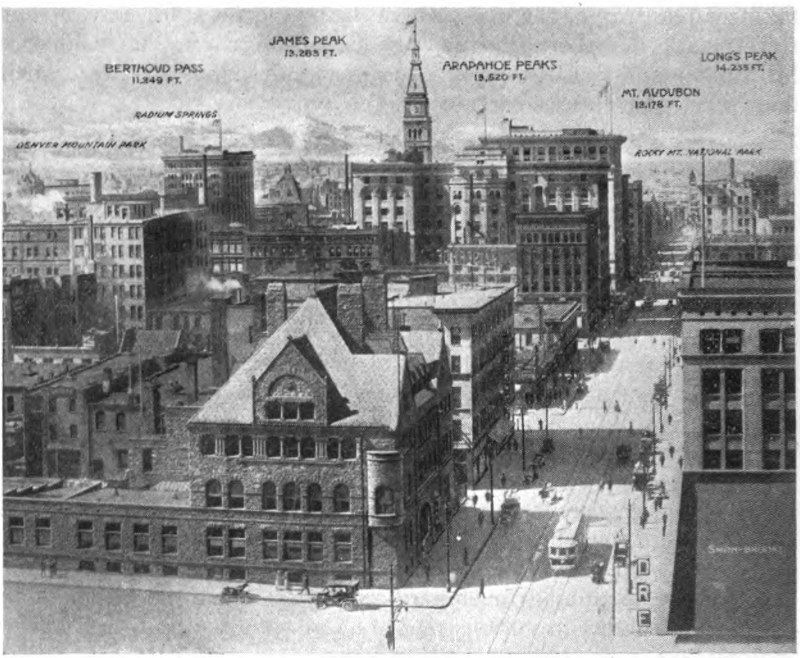


FIG. 175.—**Denver, Colo. (Courtesy Denver Tourist and Publicity Bureau.)**

hundreds of miles in extent. To the eastward the nearest town was Council Bluffs, about 1,000 miles distant. Salt Lake City is today far removed from large centers of population. It is 920 miles from San Francisco, 786 from Los Angeles, and 745 miles from Denver. It therefore draws upon and supplies a very large area.

The city is situated about 10 miles from the shore of Great Salt Lake. To the east of the city rise the snow-capped peaks of the Wasatch Mountains. From their canyons water is obtained for domestic use and for irrigation, and electrical energy for manufacturing, transportation and light. There are mineral deposits of great value tributary to the city, and building stones and clays are found in abundance.

As a result of the existence of much copper close at hand, and because coal is obtainable at low cost, much smelting is done near Salt Lake City. There are foundries and plants for the manufacture of iron and steel goods. Railroad shops are located here, and these furnish employment to many men. Among other important manufactures are cotton goods, shoes and canned fruit.

FIG. 176.—Business section of Salt Lake City.

One of the features of the city is the broad streets, usually 100 feet in width, with 16-foot sidewalks. The many trees add to the beauty of the city. The Tabernacle and the Temple are noted buildings, the latter being constructed of local granite.

The mineral wealth, the increase in manufactures, the growing importance of agriculture and the fame of Salt Lake City as a tourist resort have caused it to become quite a railroad center. The Union Pacific and the Western Pacific connect it with San Francisco. The Oregon Short Line leads to Portland and the Puget Sound country. By means of the San Pedro, Los Angeles and Salt Lake, Los Angeles and Salt Lake are brought within 24 hours of one another. The Denver and Rio Grande and the Union Pacific make connections with the eastern part of the United States.

STUDIES

By means of a map trace the railroads which cross the province. Show the relation of topography to these lines. Locate the passes which are used. What proof that the Colorado River had established its course before the uplift spoken of occurred? What indication that Yellowstone National Park is young geologically? In what way are the rivers in this province most important? What part of Utah is best watered? Why? What conditions caused Denver to become an important distributing center?

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The above bulletins, $1.00 each, are invaluable aids in interpreting the geography of the western part of the United States.

MAP OF PACIFIC COAST STATES

CHAPTER XLVI

The Pacific Coast States

Position.—As applied to the geography of the Pacific Coast States, position is an important factor. Our civilization has spread westward, and hence the position of these states with respect to the eastern part of the country is one of extreme isolation. Before the days of the railroads the overland journey from the Atlantic seaboard to the Pacific coast required several months and was fraught with hardships and dangers. The journey around Cape Horn, or even across the Isthmus of Panama, was long and dangerous.

Because of this isolation, the first settlers in these states came by sea, and the isolation and resulting ignorance concerning the country long delayed overland settlement. The position has a favorable aspect, however. It enables the Pacific Coast States to greatly profit by the rapidly increasing Oriental commerce. The opening of the Panama Canal shortens the distance between New York and San Francisco by approximately 8,000 miles. This is of great commercial importance, and will result in a rapid increase in the population due to immigration.

Coast Line.—The Pacific Coast States have few good natural harbors. This is in part due to an elevation of the continental shelf. Puget Sound, San Francisco Bay and San Diego are striking exceptions to this and are the result of subsidence, which was general from Puget Sound northward, but local south of Puget Sound. There are a number of bays having a small back country and consequently large cities have not developed upon them. At San Pedro, the port of Los Angeles, the United States government has spent several million dollars for the improvement of the harbor. San Diego has a good harbor which will be of greater importance when railroad connections with the interior have been improved.

Influence of Topography.—Roughly speaking, California consists of a great interior valley and a mountainous rim. In the interior valley and upon the coastal plain, therefore, most of the population is found. For several hundred miles the Sierra Nevadas rise like a mighty wall close to the eastern boundary of California. The mountains are largely composed of granite rocks. These, ages ago, were forced in a molten state into older rocks. As a result of changes slates and schists were formed. A long period of erosion was followed by extensive lava flows. Later the system was tilted, producing a steep eastward slope and a gentle western slope. During recent times both water and ice have been fashioning many wonderful scenic features. Majestic Mt. Shasta, 14,380 feet in altitude, is a volcanic mountain from which much lava has flowed. "During one of the later eruptions of Shasta a stream of lava (andesite) poured down its southern slope, entered the channel of the Sacramento, and followed that stream for 50 miles."[1]

On May 30, 1914, Lassen Peak, after a period of quiescence of unknown duration, became active. So frequent and so violent were its eruptions that some of the settlers were much alarmed. Up to January 1, 1917, about 200 outbreaks had occurred. Since that time the eruptions have been much less frequent. Fragmental material, steam, gases and mud have been ejected in large amounts, but up to date only a relatively small amount of lava has issued from the mountain.

The Cascade Mountains extend northward from Shasta to the southern part of British Columbia. Like the Sierra Nevada, they are lofty and contain numerous volcanic peaks, among which are Hood and Rainier. Lava is more extensive in the southern than in the northern part.

The mountains of the Coast Range extend from Mexico to Alaska. Within the province under consideration they are nowhere very high. They are recent in origin, and are in large part composed of sandstones and other sedimentary rocks. Locally there is much lava of still more recent date.

Between the Coast Range on the west and the Sierra Nevada on the east is the Central valley of California, about 400 miles long and from 40 to 50 miles wide. Into this valley the waste of the mountains has been going for centuries, building up the vast area of level and fertile land. Wells have been sunk to a depth of 3,000 feet without reaching bedrock.

The depression between the Coast Range and the Cascade Mountains is not so well defined. It consists of three parts: The Puget Sound valley, largely occupied by water, the Cowlitz valley and the Willamette valley.

The westerly winds, coming in contact with the mountains, cause abundant precipitation upon their western slopes. As one result, there are extensive forests upon the west slopes. As another

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[1] U. S. Geological Survey Bull. 614, p. 63.

result the eastern parts of all three states are deficient in rainfall, true desert conditions existing in southeastern California.

The topography has guided wagon and railroad construction, as it did the trails of early days. The passes are for the most part lofty, hence they have played an important part in determining routes of travel.

In 1805 the Columbia guided the canoes of Lewis and Clark from the western slope of the Rocky Mountains to the mouth of the Columbia. Later the Oregon Trail led northward from the Bear River in Utah to the Snake and thence to the Columbia. Today a railroad follows each bank of the river, as the valley offers the best route across the mountains. The Willamette and the Sacramento definitely guide the Shasta route.

The Truckee Pass, 7,012 feet in altitude, and nearly east of San Francisco, from the earliest days of migration from the eastward has been the land gateway to central California. Through this pass the Union Pacific Railroad was built in 1869. The pass naturally directs trade and travel by way of the Sacramento Valley to San Francisco Bay on the west, and along the valley of the Humboldt on the east. The trail which followed this route was known as the California Trail.

In the southern part of California the passes are lower, and as a result that part was settled, by people coming overland, earlier than were the central and northern parts. The Gila River led trappers across Arizona and into southern California as early as 1827. The Southern Pacific Railroad follows this trail for a considerable distance, passing through the San Gorgonio Pass in southeastern California, between San Gorgonio and San Jacinto peaks.

The Cajon Pass, altitude 4,560 feet, led those who entered California over either the Santa Fé or the Spanish Trails, across the mountains into the San Bernardino valley. Today this pass is shared by the Santa Fé and the Salt Lake railroads.

East of the Sacramento River the Feather River, a tributary of the Sacramento, has carved a beautiful canyon on the western slope of the mountains. This leads to Beckwith Pass, the altitude of which is about 5,280 feet. The precipices and canyon walls made this route impassable by wagons, but the Western Pacific Railroad has recently opened its line through this canyon, thus connecting the Bay Section with Salt Lake City.

Through its wonderful scenic features the topography of the Pacific Coast States is exercising a strong influence upon the development of the area. The Yosemite Valley is one of the wonders of the world. Lake Tahoe, Mt. Shasta, Crater Lake, Lake Chelan, Mt. Rainier and other features are yearly attracting a larger number of persons. This leads to the establishment of resorts, the building and improvement of roads, the bringing in of capital and the growth of population.

Hydrography.—Although much of the Pacific Slope is well watered, it has few rivers which are valuable from the standpoint of navigation. This is because most of the streams are short and swift. They are of great importance in other ways, however.

The Columbia is the one great waterway in the province. Its basin has an area of more than 250,000 square miles, and the river and its tributaries afford 2,000 miles of navigable waters. Ages ago the Columbia in its lower course flowed in a broad, flat valley, eroded from the basaltic rock of the region. Then an elevation occurred, and as a result of rejuvenation the river cut its channel deeper, and fashioned flat-topped hills out of parts of its old valley floor. At a later time subsidence took place, and the ocean invaded the land, drowning the Columbia for a distance of 140 miles from its mouth. This drowning produced a deep channel up and down which, centuries later, great ships were to ply bearing their valuable cargoes. There are 35 feet of water to Vancouver, and ocean-going vessels reach Portland, a few miles south of the junction of the Willamette and the Columbia.

From the standpoint of manufacturing, the river and its tributaries will be of inestimable value in time to come. "The system as a whole is capable of furnishing an estimated maximum of about 19,740,000 horse-power, of which only 351,249 horse-power, less than 2 per cent., was developed in 1909, the latest year for which complete statistics are available."[2]

Mineral Wealth.—It was gold which led to the settlement of California by people from other parts of the United States. Although gold had been obtained from some of the streams in southern California previous to 1848, it had attracted no attention outside of the region. The news of James Marshall's discovery spread as rapidly as the means of communication permitted, and as a result the white population increased from 12,000 in 1848 to 92,000 in 1850. As a result of this rapid growth of population California was admitted as a state in 1850.

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[2] U. S. Geological Survey Bull. 614, p. 26.

The output increased from $245,301 in 1848 to $81,294,700 in 1852, in which year the maximum output was reached. The total yield from 1848 to 1919, inclusive, has been about $1,617,-000,000. Because of the discovery of gold and the large influx of people, camps and towns were established in all parts of the gold-producing area. Some of the towns became permanent features, but many others soon passed out of existence. Another re-

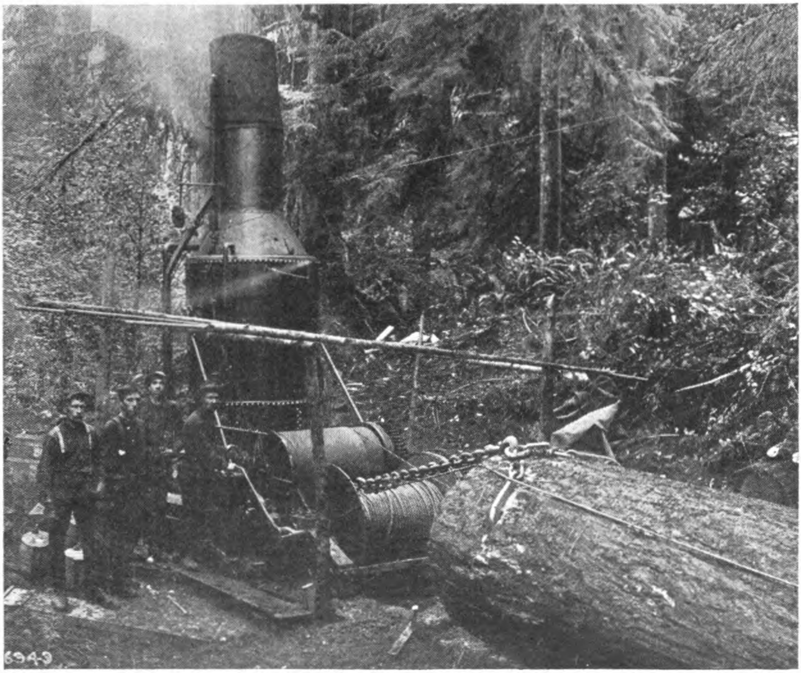

Photo from Gifford Studio, Portland, Oregon.

FIG. 177.—In an Oregon forest.

sult of the great output of gold was to hasten the building of the first transcontinental railroad, the Union Pacific. This was completed in 1869, and at once brought the East and the West into closer relationship. The time required to make the journey from coast to coast was reduced from several months to two weeks.

Although gold will for many years be one of the important products of California, it no longer ranks first among the minerals. In 1907 petroleum took the leading place, which it yet holds, and for years California ranked first in quantity although not in value of output. In 1915 Oklahoma took first place both in yield and in value. California produces about one-third of our total output of

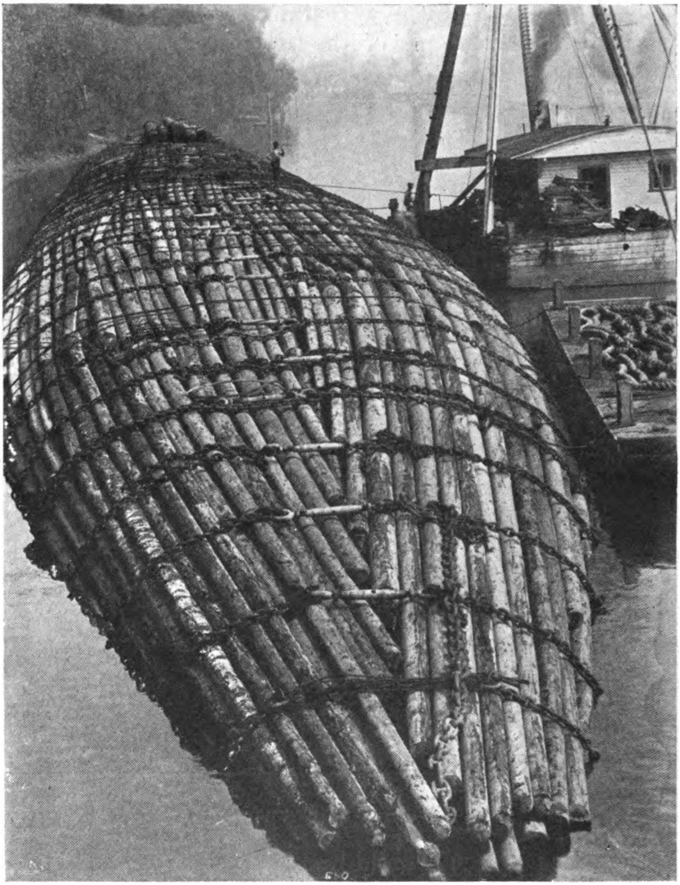

FIG. 178.—A Columbia River log raft, called locally "cigar raft." (Courtesy Portland Chamber of Commerce.)

petroleum, the value of which is about one-fifth the value of the output for the United States.

Manufacturing, so long retarded in California because of lack of coal, has received a marked impetus on account of the use of petroleum. It is used on locomotives in all parts of the state and in much adjoining territory and on steamships. Much oil is used on streets and roads as well.

Silver, copper, borax, salt, mercury, clay and building stones are other forms of mineral wealth possessed by California. This is the only state yielding mercury in commercial quantities.

Of the Pacific Coast States, Washington is the only one in which coal mining is important. There are coal mines within 10 miles of Puget Sound and yet most of the steamers on the Sound use petroleum, and its use on the railroads is increasing. Where oil is employed, less labor is needed, traveling is more cleanly and, in the case of the railroads, forests are protected because of absence of sparks.

Forest Resource.—As has been stated, the abundant precipitation upon the western slopes of the mountains and the mild temperature favor the growth of dense forests. About one-third of the standing timber in the United States is in this area. Twenty-four per cent. of the total area of California is classed as forest. In many cases a single tree on the Pacific Slope yields thousands of feet of lumber.

From Bellingham, Everett, Seattle, Tacoma and other Puget Sound ports large quantities of lumber are shipped. Logs are floated down the Columbia and the Willamette, and Portland exports a great deal of lumber. Eureka and Arcata, on Humboldt Bay, and San Francisco are lumber-shipping centers. Lumber is shipped from the Pacific Coast States to the Orient, South America, Europe and our Atlantic seaboard.

In California the streams in the forest area, owing to their torrential character, cannot be utilized for the movement of logs as they are in the New England and Lake States. As a result, flumes are constructed in which streams of water carry lumber from the mountains to the valleys. Lumber is flumed 40 miles to Red Bluff and 57 miles to Madera, and there are many flumes of considerable length.

Aside from the demand made by building, much lumber is used in the Pacific Coast States for supports in mines, in the manufacture of various kinds of boxes and beehives and in the making of matches. At Chico, California, the Diamond Match Company has an immense plant.

Climate.—In these states climate is a geographical factor of unusual significance. The prevailing westerly winds bring to them from the Pacific Ocean the uniform temperature conditions which prevail over this great water area. Seasonal temperature ranges are therefore slight and the annual isotherms extend practically north and south. Seattle, although in the latitude of the northern part of Maine, seldom has snow enough to make the use of sleighs possible, and San Diego, in the latitude of Charleston, South Carolina, has delightfully cool summers.

Upon the lofty mountains and in the eastern parts of Oregon and Washington low winter temperatures prevail. In much of the area diurnal temperature ranges are great. This is due to low relative humidity, which causes radiation to go on very rapidly. Even in southern California the nights are nearly always cool. This phase of the climate is of great value.

The amount of the annual precipitation, as well as the number of rainy days, decreases from north to south. In Seattle the mean annual precipitation is 36 inches; in Portland, 45 inches; in San Francscio, 22 inches; in Los Angeles, 15 inches, and in San Diego, 9 inches. This is due to the fact that with the annual movement of the earth about the sun, the temperature belts, and hence the wind belts, shift north and south. The cyclonic storms which bring the rain to the region cut the coast farther north in summer than they do in winter. Most of the precipitation occurs during the winter. In Los Angeles about 96 per cent. of the total for the year occurs between November 1 and April 30. In Seattle about 75 per cent. of the total falls during the same time. The length of the rainy season increases with increase in latitude.

In California there is an interesting inversion of temperature. The southern part of the Sacramento valley and the valley of the San Joaquin, being cut off from the sea by mountains, are much less subject to winter fog than is the Los Angeles Coastal Plain. As a result, they experience higher temperatures and an earlier ripening of fruit. Fruits from the central part of the state 500 miles north of Los Angeles are on sale in that city several weeks earlier than the same fruits ripen in the south.

The mild conditions of temperature have resulted in making the Pacific Coast States a great fruit-growing area. Oregon produces many apples, peaches, pears, cherries, prunes and small fruits. California leads the Union in the production of peaches, apricots, prunes, oranges, lemons and grapes. It produces nearly all of the raisins, figs, olives and dates grown in our country.

As applied to the production of raisins and the drying of deciduous fruits, the absence of summer rains is an advantage that can scarcely be overestimated, for the drying can be performed in the open air at slight cost. The dry summers are of great value to grain and hay crops, as there is no loss because of storms and the low relative humidity makes possible the use of combined harvesters.

The character of the climate is attracting large numbers of people to the Pacific Slope. During the decade closing with 1920 the population of the United States increased 14 per cent., that of Washington 18 per cent., that of Oregon 16 per cent., and that of California 44 per cent. This increase in population is very small as compared with that of the previous decade. The slowing-up was, in large part, due to the many restraining conditions resulting from the World War.

Industries.—For a number of years following 1848 mining was almost the only industry in California. As the yield of the streams and mines began to decrease, and with the increasing demand for supplies of food, a part of the population naturally turned to agriculture. The ease with which the land could be cultivated in the Great Valley, the absence of forests to be cleared away and the fertility of the soil all favored this industry.

Wheat has always been an important crop in these states, but as the advantages to be derived from fruit culture became more evident, wheat growing has declined relatively in favor of horticulture. Wheat is yet the leading crop in Washington and Oregon, and is one of the exports of all three states.

Irrigation, which greatly increases the certainty of crops, has done much to promote agriculture in this section. Large areas, but a few years ago in a desert condition, now yield immense crops and support a prosperous population. In eastern Washington, for example, good apple orchards are worth $1,000 per acre. Among the important government irrigation projects are the Klamath, partly in California and partly in Oregon, and the North Yakima Project in south-central Washington.

In California the citrus fruit industry has assumed vast proportions, and in all of the states of this group fruits are dried and canned in large quantities. Apple growing in Oregon and in eastern Washington is important.

As has been indicated, lumbering is an important industry in the Coast Range north of San Francisco, on the western slope of the Sierra Nevada and in Oregon and the Puget Sound country. In Washington the forests form the chief basis of industrial development.

Fishing in Puget Sound, in the Columbia and in the lower Sacramento is important. Great quantities of canned salmon are exported.

Until recent years, owing to lack of coal, there has been little manufacturing. The use of crude oil and of electrical energy developed from water power have led to a marked development in manufacturing, however. A large amount of power can be developed from the streams because of their great fall. At Spokane power has been developed from the river of the same name and is used in the manufacture of flour. Seattle has an abundance of cheap power obtained from the streams that flow from Mt. Rainier. The Puget Sound Light and Power Company, utilizing water from Lake Tapps, which

Photo by B. W. Griffith.

FIG. 179.—Mt. Rainier, from Indian Henry's Hunting Grounds.

is southeast of Tacoma, has developed 80,000 horse-power. Portland derives power from Mt. Hood, and the Falls of the Willamette have led to manufacturing at Oregon City, Oregon.

It is estimated by Clapp and Henshaw in Water Supply Paper 271, page 118, that 6,000,000 horse-power can be developed from the streams of California. Approximately one-half of this total is in the Sacramento basin. At present, power is transmitted to the Bay cities from the Feather and the Yuba Rivers. Los Angeles and other cities in southern California are using power developed from the mountain streams. It is estimated that the Owens River Project will furnish to Los Angeles and vicinity 100,000 horse-power.

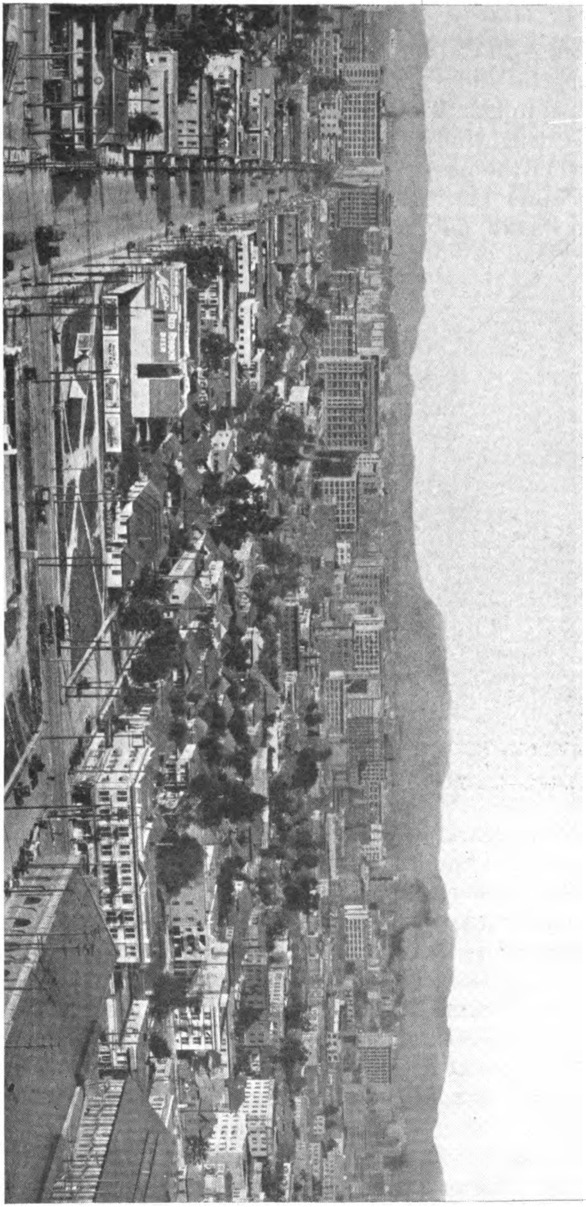

FIG. 180.—A scene in Los Angeles.

CITIES

Los Angeles.—In California there are two great centers of population, Los Angeles and San Francisco. Los Angeles is situated upon the fertile coastal plain, where water can easily be secured and where the climate is delightfully tempered by the sea breeze. The roads that make use of the passes leading from the Central valley, as well as those that enter the coastal plain by way of the Cajon and the San Gorgonio Passes, naturally converge here.

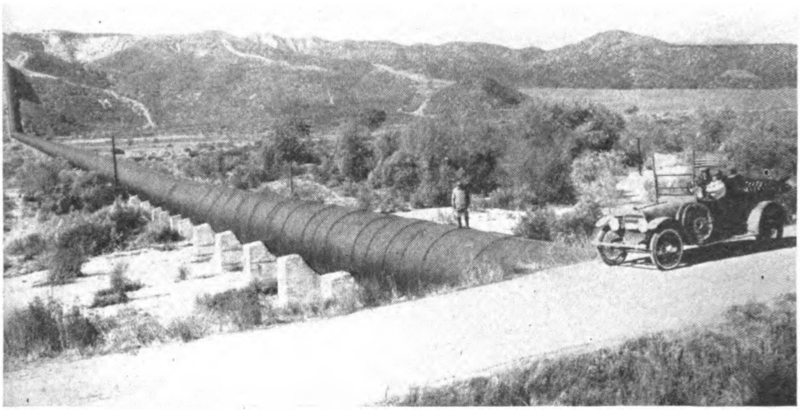

FIG. 181.—The Los Angeles aqueduct. (Courtesy W. G. Scott.)

Los Angeles is nearly 20 miles from the sea, but a good harbor has been developed at San Pedro, where the government has expended some $5,000,000. The city has annexed what is known as the "shoe string" strip extending to the harbor and including the city of San Pedro. Los Angeles is therefore in effect a seaport.

A few years ago the city at great cost undertook to bring water from Owens River, some 200 miles distant. As the aqueduct was constructed across a desert and as mountains had to be tunneled, the project was one of great importance. Water more than sufficient to meet all needs is now available, and, as stated above, much power has been created.

Los Angeles is the supply center for a large agricultural area. It also furnishes machinery and other supplies to mining companies operating upon the Mohave Desert and in Arizona. It has railroad connections with the East by way of the Southern Pacific, Santa Fé and Salt Lake Railroads, and with the North and also the East, by way of San Francisco, over the Southern Pacific.

In 1781 the Spanish founded a settlement where now is situated Los Angeles. In 1846 the town came into the possession of the Americans. So slowly did the town develop that in 1885 its population was but little more than 11,000. According to the census of 1920, Los Angeles had a population of 576,673, a gain during the decade ending with that year of 80 per cent.

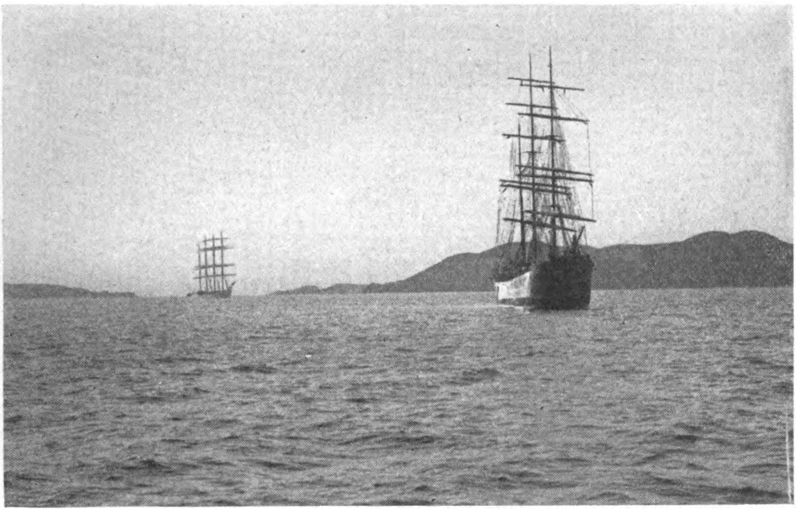

FIG. 182.—The Golden Gate, San Francisco Bay. (Courtesy Southern Pacific Company.)

Los Angeles has foundry and machine shops, and car shops where cars are made and repaired. Much meat is packed here, and some flour is manufactured, partly from wheat grown in the near-by San Fernando valley. The city handles much lumber, most of which is landed at San Pedro. The extensive development of the fruit industry in the surrounding section has led to the manufacture of boxes of many kinds, and the honey industry is responsible for the manufacture of hives. Clay is found in abundance in the vicinity, and there are several brick-making establishments, and tile and sewer-pipe are made.

San Francisco.—Although California has nearly 1,000 miles of coast line, San Francisco Bay is the only one that extends into the heart of the state. Here there is an area of about 300 square miles affording deep and protected anchorage. The bay was formerly a valley formed by faulting. As a result of subsidence the ocean flooded the valley, converting it into a bay, the islands in which are partially submerged hills. The valleys of the Sacramento and the San Joaquin lead directly from the north and the south respectively to this bay, thus making a large part of the state directly tributary to it. Truckee

Photo from Gifford Studio, Portland.

FIG. 183.—Bird's-eye view of Portland, Oregon. Mt. Hood in the distance.

and Beckwith Passes are the natural gateways on the landward side. The position of the bay makes the cities upon its shores the great ports and distributing centers of the state, and here we find one of the two great centers of population and industry. San Francisco in 1920 had a population of 508,401, and its increase during the decade closing in 1920 was 22 per cent.

The Metropolitan District on the Bay includes San Francisco, Oakland, Alameda, Berkeley and much other territory. Here ships from all parts of the world discharge and receive cargoes. Tea, silk, and rice from the Orient, coffee and rubber from Brazil and sugar from Hawaii are among the imports. Wheat, lumber, dried fruits and canned salmon are some of the exports.

In 1910 San Francisco and Oakland had 83 per cent. of the total population of the Metropolitan District, 88 per cent. of the manufacturing establishments, employed 85 per cent. of the labor and in point of value produced 78 per cent. of the manufactured articles.

In San Francisco the leading industries are meat packing, manufacture of tools and machinery, baking, roasting of coffee and spices, canning and preserving fruits, refining of sugar, the manufacture of lumber and timber products and the making of men's clothing.

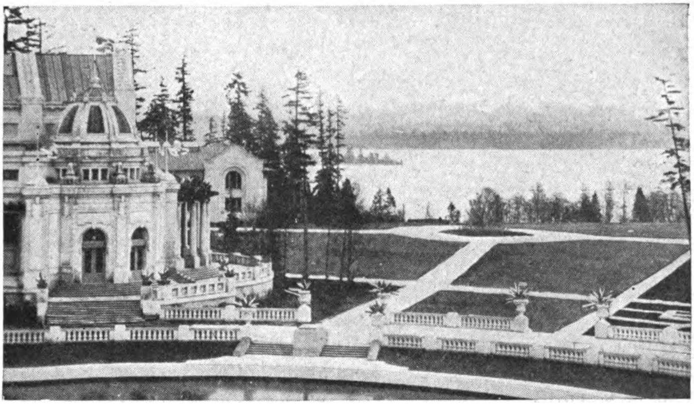

FIG. 184.—End of Manufacturers' Building, with Cascade Mountains in distance, Seattle.

In Oakland the production of bakery goods, canned and preserved fruits, twine and foundry and machine shop goods are important industries. Oakland has done a wonderful work in improving her harbor facilities.

Portland, which was named in honor of Portland, Maine, is practically at the junction of the Willamette and the Columbia Rivers. It is therefore at the crossing of the two routes of trade, and it draws upon large areas rich in natural resources. Being at the head of deep-sea navigation gives the city yet another advantage. An abundance of cheap power is obtained from the streams that flow westward from Mt. Hood and other mountains of the Cascade System. This is used in lignting, transportation and in manufacturing.

Portland exports lumber, wheat, flour, apples, canned salmon and wool. Its chief imports are furniture, carpets, machinery, hardware, silk, tea, coffee, spices and burlap. In 1920 it had a population of 258,288, and the increase during the decade ending in 1920 was 24 per cent.

Seattle occupies a most advantageous position on Puget Sound. In front of her lies Elliott Bay, an arm of the Sound affording deep water, and behind her is Lake Washington. The city is situated

Photo by B. W. Griffith.

FIG. 185.—Mt. Rainier from Paradise Valley. Nesqually Glacier in the foreground.

upon an arm of land between the two bodies of water, which are now connected by a canal.

In the immediate vicinity of Seattle are great forests. Indeed, in 1852 a man named Yesler put up a steam saw mill where is now the heart of the city. On the shores of Lake Washington there are saw mills where immense logs are being converted into lumber, and shingles and lumber are two of the leading exports of Seattle.

East of the Cascade Mountains lies the Inland Empire, a region rich in wheat and apples. Some of the wheat of this area reaches Seattle and is from there exported. Canned salmon in large quantities is shipped also.

Seattle is the chief supply depot for Alaska. By means of the

"Inland Passage" there is a sheltered water route as far as Skagway. Provisions, clothing, mining machinery, cans and boxes are shipped to the various fishing towns along the coast and to the mining districts in the interior. Gold and salmon are shipped from Alaska to

FIG. 186.—A scene in Spokane.

Seattle. During the summer season 10 or more vessels leave Seattle for Alaska weekly.

Four railroads connect the city with the East, and steamship lines carry on commerce with the Orient. Coffee, tea, silk, sugar, spices, cotton, hides, meats, furniture and hardware are the leading imports.

Power for manufacturing as well as for illumination and transportation is developed from streams which flow from Mt. Rainier.

Seattle was built upon very hilly ground, the deposits of glaciers. Just a few years ago the people determined to remedy this. Millions of dollars have been spent in cutting down hills by the use of hydraulic force. Streets to the extent of many miles have been entirely regraded and large numbers of houses were kept blocked up on stilts while the dirt beneath was removed and then lowered many feet. The glacial drift upon which the city is built made this work much less expensive than it would otherwise have been. During the decade ending in 1920 the population increased 33 per cent. and in 1920 was 315,652.

Spokane.—Fifty miles from where the Spokane River unites with the Columbia is situated Spokane, an important industrial and railroad center. It is the chief distributing point for a large area in eastern Washington, northeastern Oregon and northern Idaho.

Within the great bend of the Columbia wheat and fruits are grown extensively. Much wheat is milled at Spokane because of the power furnished by the Spokane River, which has a fall of 150 feet within the city. Power is transmitted to the Coeur d'Alene silver-lead mining district in northern Idaho, about 100 miles distant, and is used in Spokane in various industries and in transportation.

Owing to the great resources of the tributary country, and to the power furnished by the river, Spokane has had a remarkable growth during recent years. In 1920 its population was 104,437, and it ranked second among the cities of Washington in this respect.

STUDIES

Make a study of the advantages and disadvantages in the position of the Pacific Coast States. What would be the result if the Coast Mountains were higher than the Sierra Nevada and the Cascade Mountains? Locate all of the passes mentioned. Show how mineral wealth has influenced the development of the area. How is climate related to lumbering? Account for the position of the isotherms, as shown on an annual isothermal chart. How is the fertility of the soil in the semi-arid sections related to light rainfall? What has been done to increase the commercial importance of the Columbia River? Show why these states have increased in population so rapidly.

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CHAPTER XLVII

ALASKA

Area and Population.—The combined areas of France, Germany and the British Isles do not equal that of Alaska. Practically 12 states, each having an area equal to that of New York, could be made from Alaska. In 1920 the population of this vast area was but 64,356. Unlike the states in the western part of our country, Alaska showed little increase in population during the decade ending with 1920. A large part of the total population is situated close to the coast. This is in part a response to favorable climatic conditions, and in part a response to conditions which favor the fishing industry.

Influence of Climate.—In Alaska latitude is not the chief factor in determining climate. The southern part of the territory, as far north as the middle of Hudson Bay and Point Barrow, is 10 degrees north of the northern coast of Labrador, yet the climate along the southeastern coast of Alaska is very mild.

At Sitka the mean January temperature is but 31° F., and the mean August temperature is 55° F. At Point Barrow the mean temperatures for the same months are —15° F. and 38° F. Mildness and slight seasonal ranges characterize temperature conditions along the coast, while in the interior the ranges are great. Winter temperatures in the interior fall to —70° F. in some places, and the ground, except close to the surface, is permanently frozen to a depth of many feet. Low temperatures keep the Yukon closed to navigation for more than one-half of each year.

Along the Pacific coast precipitation is very high because the Coast Range causes the westerly winds to give up their moisture. The annual precipitation varies from 50 to 190 inches. At Sitka there are on the average 207 days each year on which rain or snow falls. The precipitation in the interior is light, ranging from 11 to 21 inches annually.

The climate exerts a marked control over dress, character of homes, heating and lighting, industries and means of transportation. When the Yukon River, which is the natural route to the interior, is closed by ice, sledges drawn by reindeer or dogs are, aside from travel on foot, the only means of transportation.

The Coast Line.—Southeastern Alaska has a fiorded coast line of remarkable irregularity. Including the minor irregularities—and these must be surveyed—the total length of the coast line of the territory is placed at 26,376 miles. The character of the coast line is in part the result of a drowning of the region and is in part the result of glacial action. Between the mainland and the countless islands which lie off shore there is a sheltered channel nearly 1,000 miles in length and extending from Seattle to Skagway. This channel is known as the "Inside Passage" and is much used by coastwise vessels.

Nature has here produced a coast line which for grandeur of scenery is excelled in few parts of the world. It is yearly being enjoyed

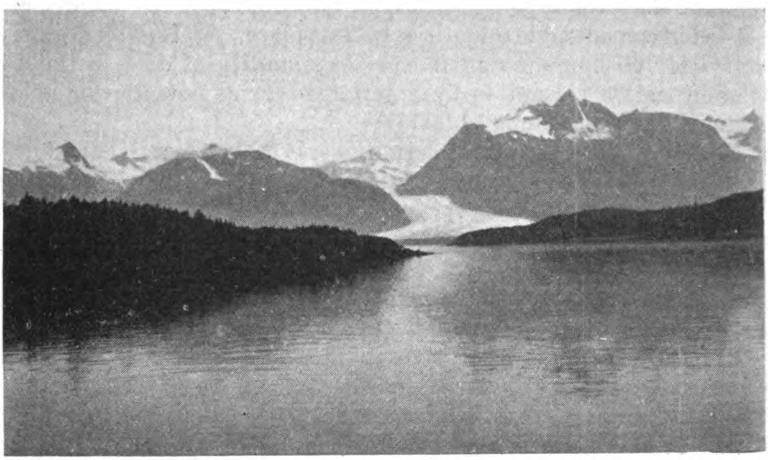

Photo by Chamberlain.

FIG. 187.—On the coast of southern Alaska.

by larger numbers of people. The deep and protected anchorages in the fiords furnish the sites for the fishing and canning stations.

Because of the irregularities of the coast, the prevalence of fogs and the increasing commerce and tourist business, the maintenance of lights along the Inside Passage is a matter of much importance. Many of the lights are operated by acetylene gas and burn continuously for a period of about 6 months. This makes it unnecessary to station lighthouse keepers at these points.

Topography.—The Coast Mountains rise very precipitously from the water's edge. A large number of the peaks are snow covered and many glaciers descend to the Pacific. Some of these are quite accessible from the Inside Passage and a large number are visible. The mountains are a great barrier to those who wish to reach the interior from the southeast. The White Horse Pass and Yukon Railroad follows the course of the trail over which so many thousands passed in the years immediately following the discovery of gold in the Klondike. Skagway is at the seaward end of this railway, which affords an easy entrance to the Yukon valley.

Some of the Coast Mountains are volcanic. The eruption of Mt. Katmai, which is on the west shore of Shelikof Strait, about 100 miles from Kodiak, was probably the most violent volcanic action ever recorded, and yet no loss of life resulted. This is in large measure due to the fact that the country is very sparsely populated. The sound of the explosion was heard in Juneau, 750 miles distant, and dust fell in considerable quantities at that place. At Kodiak darkness reigned for 60 hours, so great was the quantity of dust in the air. The only active volcano in the interior, so far as now known, is Mt. Wrangell, altitude about 14,000 feet.

Mt. McKinley, in the Alaskan range, is 20,300 feet in height, and under favorable conditions is visible for more than 100 miles. Although there are various ranges in the interior, the general character of the surface is that of a plateau or a plain. There are vast stretches of tundra and there are areas where there is excellent summer pasturage. Owing to the light precipitation and the long annual period of very low temperature, there is comparatively little timber.

Rivers.—The one great river of Alaska is the Yukon, and it is one of the great rivers of the world. Its head waters are in British Columbia, and as has been stated, the valley can be reached by way of the White Horse Pass and Yukon Railroad. There are canyons through which the river runs rapidly and flats across which it flows sluggishly, frequently changing its channel. This makes navigation difficult.

The river is open to navigation for less than one-half of the year, but during this time it is the chief route to the interior. Several distributaries extend across the delta. The northern channel, known as Apoon Pass, is the one commonly used. It has a minimum of 4 feet of water. There is no harbor on the delta, but there is an inferior one on St. Michael Island, 60 miles distant. Here sea-going boats load and unload, and hence St. Michael has assumed some importance.

Furs.—For many years furs constituted the only source of wealth. Both sea and land animals were utilized. The fur seals make their summer home in the Pribilof Islands. The animals are killed under government regulation and upon payment of a stipulated sum to the government. Pelagic or ocean sealing has greatly reduced the number of seals. The number killed in 1867 is variously estimated at from 2,000,000 to 4,000,000. In 1918 only 35,000 were killed. The average value of the fur of a seal is about $30.00.

In addition to the fur seals, there are foxes, beaver, muskrats and other land animals the furs of which are commercially valuable. A first-grade black or silver-gray fox is worth more than $1,000.00. The total value of the furs, chiefly seal, taken in Alaska since the purchase is about $60,000,000.

Mineral Wealth.—In 1880 a man named Juneau discovered gold on Douglas Island, and later it was discovered in the interior. The long winters in the interior are an obstacle to mining. From 1880 to 1919, inclusive, Alaska has yielded about $311,000,000 worth of gold, and in the last named year it ranked third in the output of this metal. The cost of transporting machinery to the mines in the Yukon district is very great. The famous Treadwell Mine, being situated at tidewater, has a great advantage in this respect. In the interior placer mining is carried on extensively.

In addition to gold, there are copper, lead, silver, tin, petroleum, coal and other forms of mineral wealth. There are large deposits of anthracite coal. So cheap is water transportation, however, that coal is shipped to Alaska from Seattle. In the neighborhood of 90 per cent. of the value of the total mineral output is in the form of gold.

Fishing.—During recent years the fishing industry has developed remarkably in Alaska. The sheltered Inside Passage and the tidal streams favor fishing, and the location of canneries and salteries. Many little fishing villages are located at the heads of the fiords, and new canneries and salteries are established yearly.

Although the salmon is the chief fish taken, cod, halibut and herring are being caught in increasing numbers. Probably eight-ninths of the value of the total catch is represented by the salmon. Halibut are shipped to Seattle packed in glacier ice. From 1867 to 1919, inclusive, the value of the fish taken in Alaskan waters was more than $300,000,000. Some 200,000,000 cans of salmon are shipped yearly.

Although there is much timber along the coast, some of the material for the cases in which the cans of salmon are packed is shipped from Seattle. This is because there is timber immediately tributary to Seattle, water transportation is cheap and labor in Alaska is very high. Alaska cannot export lumber, as the laws of the territory forbid this. Wood is burned on the Yukon steamers and timbers are used in the mines. Probably the pulp industry will in time develop.

Alaska has a considerable number of establishments engaged in producing lumber products, but the total value of the output is relatively small. Spruce is the chief lumber used. Material for salmon cases, shingles, building, mine-props and piling in part meets the local demand.

Agriculture.—For many years no one believed that agriculture could be carried on in Alaska. Now there seems to be danger that the agricultural possibilities will be exaggerated. The climatic conditions are most favorable along the southeastern coast, and here there is little land available. In the interior the short growing season is in part balanced by the very long days.

The total area of the cultivated land in Alaska is small. Along the coast where the climate is most favorable the country is very mountainous. In the interior the growing season is short and transportation facilities are poor. Both of these conditions limit agriculture. Excellent barley, wheat, oats, potatoes and vegetables are grown in small quantities near the coast. Very fine berries are produced and several varieties of apples are grown.

Naturally domestic animals are not very numerous. Many years ago our government introduced reindeer into Alaska. These hardy animals were brought in from Siberia. They are of great value to the people, especially to the natives, who obtain from them meat, milk and material for clothing. The reindeer are important in transportation also. For the last named purpose dogs in considerable numbers are used. Cattle are much more numerous than are horses, hogs or sheep, and grazing is certain to increase in importance. As conditions become better known, Alaska may produce a large part of her own food supply, but there is little indication that she will ever be an exporter of agricultural products.

Roads.—Lack of cheap transportation always retards development. Owing to isolation and to climatic and topographic conditions, the cost of building roads of any kind in Alaska is very great. There are only about 1,000 miles of wagon and railroad in the entire territory. The cost of shipping goods from Seattle to the interior varies from $5.00 to $200 per ton, according to the nature of the commodity.

Influence of Scenery.—One of Alaska's sources of wealth is her beautiful scenery. As this cannot be exhausted through use, the returns will steadily increase as the country becomes better known. The Inside Passage affords a summer trip that is probably unexcelled. There is little rough water, and the countless wooded islands, the snow-capped peaks, the great glaciers and the beautiful


ALASKA
ENGRAVED BY
L.L.POATES ENG. CO., N.Y.
Scale of Miles
0 50 100 200 300
Important Cities are shown in Heavy Face Type
Continuation of
ALEUTIAN IS.
Same scale as main map
L.L. POATES ENG. CO., N.Y.
Long. 164 West from 160 Greenw.
ARCTIC OCEAN
ASIA
ARCTIC CIRCLE
GULF OF ANADIR
BERING STRAIT
BERING SEA
PACIFIC OCEAN
GULF OF ALASKA
BRISTOL BAY
NORTON SOUND
ALEUTIAN ISLANDS
BERING SEA ALEUTIAN ISLANDS
DOMINION OF CANADA
NORTHWEST TERRITORIES
YUKON
BRITISH COLUMBIA
ROCKY MTS.
ALASKA RANGE
ENDICOTT RANGE
SEWARD PEN
ALASKA PENINSULA
KENAI PEN
ST. LAWRENCE I.
ST. MATTHEW I.
NUNIVAK I.
PRIBILOF IS.
ST. PAUL I.
ST. GEORGE I.
KODIAK ISLAND
UNALASKA I.
UNIMAK I.
QUEEN CHARLOTTE IS.
Dixon Entrance
Nome
St. Michael
Fairbanks
Juneau
Sitka
Valdez
Cordova
Seward
Skagway
Dawson
Forty Mile
Circle
Fort Yukon
Eagle
White Horse
Wrangell
Mt. McKinley
Mt. St. Elias
Mt. Logan
Mt. Wrangell
Mt. Hayes
Mt. Foraker
Yukon R.
Koyukuk R.
Tanana R.
Porcupine R.
Kuskokwim R.
Mackenzie R.
Pt. Barrow
C. Prince of Wales
East Cape
Kotzebue Sound
Cook Inlet
Shelikof Strait
Great Bear Lake

fiords, with their picturesque fishing villages, combine in affording rest, pleasure and profit. There are fiords as grand as those of Norway; islands as beautiful as those in the St. Lawrence; mountains more lofty than any in the Alps, and glaciers larger and more magnificent than those of Switzerland.

Cities.—Alaska has no large city. Fairbanks, in the interior on the Tanana River, is a distributing point for a large area. In 1910 it was the largest city and had a population of 3,541. Nome, on the

Photo by Chamberlain.

FIG. 188.—Juneau, Alaska, from the sea.

south shore of Seward Peninsula, is about 140 miles south of the Arctic Circle. It owes its importance to the fact that there is here much dredging for gold. So far north is it that in June no artificial light is needed between two o'clock A.M. and nine o'clock P.M. Skagway is at the northern end of the Inside Passage and is the coast terminal of the White Horse Pass and Yukon Railway. Juneau the capital, is situated on the coast at the foot of the mountains of the same name.

It is evident that the purchase of Alaska from Russia in 1867 for $7,200,000 was a very good investment. The territory has paid for itself many times. The area is in its infancy, and the value of its minerals, fish, forest and agricultural products will increase for many years. There are vast kelp beds which will probably be used in the manufacture of potash. As new roads are built the cost of transportation, and therefore the cost of living, will decrease. In proportion to its area, however, the country will never support a large population.

STUDIES

Draw, to the same scale, rectangles showing the comparative areas of Alaska and the United States proper. What is the most important geographic factor in Alaska? Explain fully. Why is the national government giving so much attention to the development of Alaska? Discuss the probable increase in population. What are the opportunities for agricultural development?

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MAP OF PORTO RICO

CHAPTER XLVIII

Insular Possessions of the United States

PORTO RICO

General Statement.—In the year 1493 the island of Porto Rico was discovered by Columbus. A century before the founding of Jamestown the first white settlement was established in Porto Rico. Early in the sixteenth century Ponce de Leon founded a town to which he gave the name of San Juan Baptista de Puerto Rico. From this town the island derived its name, which means "Rich Port" or "The Gateway of Wealth." With the exception of a few weeks during the year 1597, Porto Rico was continuously held by the Spanish until the signing of the Treaty of Paris on December 10, 1898. By this act Spain ceded the island to the United States.

Topography.—Porto Rico has little level land. Most of the area is mountainous or hilly. This does not prevent cultivation, however, for the stickiness of the soil and the forest cover have hindered rapid erosion. The chief uplift extends in a general east to west direction, thus dividing the island into a north and south slope. The relation between the trend of these mountains and the northeast trade winds is such as to cause the north slope to be well watered and the south slope to be deficient in rainfall.

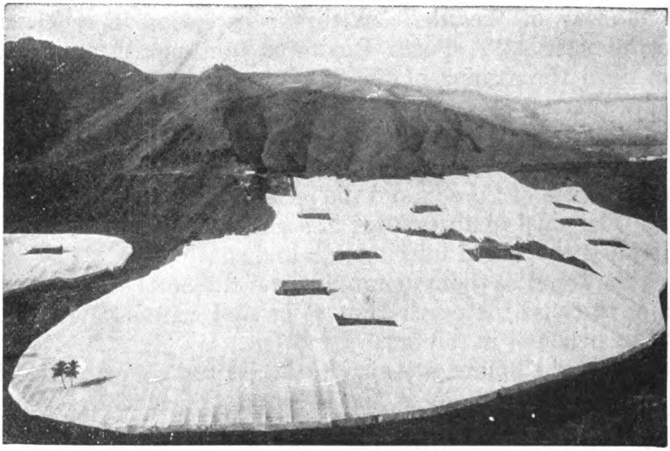
Influence of Climate.—Owing to its latitude, Porto Rico has a warm climate. Nowhere is the altitude sufficient to cause cold weather. As no point is far from the ocean, the temperatures are moderate and the ranges slight. The mean annual temperature at San Juan is about 78° F. Temperatures of 55° to 65° F. are considered cold by the natives. Snow and ice are unknown even upon the mountains.

As has been stated, the northeast trades bring heavy precipitation to the northern slope. On El Yunque, the most lofty mountain on the island, altitude 3,609 feet, the average annual precipitation is about 130 inches. At San Juan the rainfall averages more than 50 inches yearly. In December, 1893, the rainfall in this city amounted to 17.66 inches.

Because of the greater precipitation on the north slope, this area has more timber than has the southern. Upon the drier southern slope agriculture in a measure gives place to pasturage. Irrigation is practiced, and more extensive projects have been planned.

Industries.—Agriculture is the one great industry in Porto Rico, and nearly all of the total area is in farms. High temperature and abundant rainfall cause a rapid weathering of the rocks and consequently soil covers the mountains to their summits. Agriculture is therefore practiced upon very steep slopes.

Owing to the tropical climate, sugar, coffee, tobacco and fruits are extensively grown. Sugar is by far the most valuable crop, and for the three years ending with 1919 the average value of the crop was about $56,000,000. The areas tributary to Ponce and Arecibo are the most important. On the slopes, ranging from 600 to 2,400 feet in altitude, coffee and tobacco are the leading crops.



Reproduced by permission of Philadelphia Museums.

FIG. 189.—A tobacco field covered with cloth for protection, Porto Rico.

The freedom from frosts, the cheap labor and the transportation by water give Porto Rico a great advantage in the production of citrus and other tropical fruits. Owing in part to the work of the Experiment Stations, the exportation of fruits has had a remarkable growth. The fruit industry is rapidly increasing in importance, the exports of citrus fruits in 1919 being worth more than $1,500,000. During the same year the value of the pineapples exported was more than $1,000,000. The yield of coffee is being increased through the work of the Experiment Stations.

Most of the manufacturing and most of the commerce of Porto Rico grow out of the sugar, coffee, tobacco and fruit crops. Sugar, molasses, coffee and tobacco constitute a very large part of the total value of all exports. There is no mineral fuel in Porto Rico, and the use of wood for such manufacturing as is carried on is a considerable drain upon the forest wealth.

Roads.—A railroad extends along the northern lowlands nearly the full length of the island, connecting with San Juan. Another railroad serves the great sugar districts in the south and southwest, connecting Ponce and Mayaguez. A splendid wagon road extends across the island from San Juan to Ponce.

Cities.—Practically all of the cities are on or near the coast. San Juan, the most populous city, is situated on a small island off the north coast. It is connected with the mainland and a good harbor by a causeway and bridges. Its chief exports are coffee and sugar. In 1910 its population was 48,716.

Ponce, on the south coast, is about 3 miles from its port, Playa de Ponce, with which it is connected by means of an electric line. Sugar, tobacco and fruits are among the exports. Its population in 1910 was 35,027.

Inhabitants.—For an agricultural country Porto Rico is densely populated. Although her area is but 3,435 square miles, she had in 1920 about 1,250,000 people, or 364 per square mile. In 1910 almost exactly two-thirds of the total population was made up of whites, while 30 per cent. were mulattoes and the remainder blacks.

Schools are multiplying, and yet when the last census was taken two-thirds of the total population were unable to write. The people have been greatly hampered by the prevalence of the hookworm disease. The government has established a large number of dispensaries and is giving free treatment. Thousands of persons have already been cured. The scientific study of agriculture, the growth of schools and construction of roads are other important causes leading to the rapid development of Porto Rico.

THE HAWAIIAN ISLANDS

General Statement.—A little more than 2,000 miles southwest of San Francisco lie the Hawaiian Islands. As is shown by a map or globe, their position is one of extreme isolation, and in early times the inhabitants were practically cut off from the rest of the world. The position of these islands is today one of great importance, for many of the ocean routes across the Pacific converge here. As a naval base, a coaling and a cable station the Hawaiian Islands are very advantageously situated. A cable completed in 1903 connects the islands and San Francisco.

Volcanoes.—There are nine inhabited islands in the group, of which the most important are Hawaii, Maui and Oahu. The group is of volcanic origin and is geologically recent. Hawaii is practically composed of four volcanoes, the largest of which is Mauna Loa. The crater of this volcano is, roughly, 3 by 2 miles in its dimensions and is 1,000 feet deep. When not in action it is safe to descend to the floor of the crater. Streams of lava 50 miles long and one-half mile in width have poured from this volcano. Mauna Loa is 14,000 feet in altitude, and as the water close to the shore of the island is 16,000 feet deep, we can form some conception of the vast quantity of lava which has been poured out and from which the island has been built up. The volcanoes of these islands are of the non-explosive type.

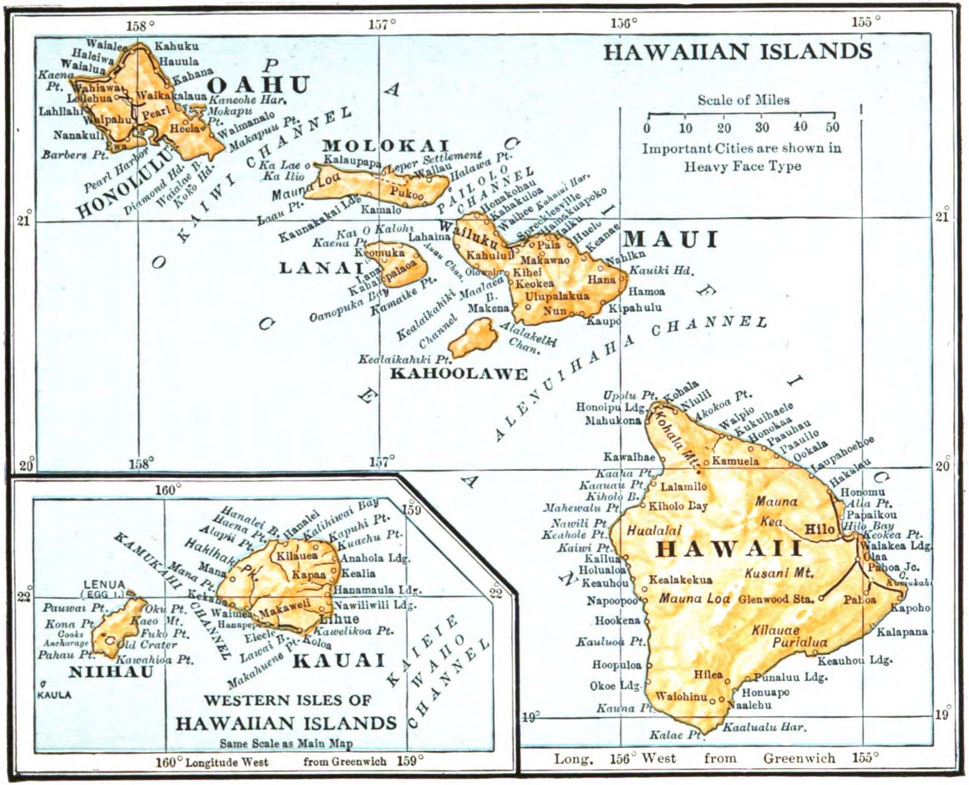
Climate.—Owing to the latitude, which is about the same as that of the West Indies, the climate is tropical. As a result of the influence of water, the climate is remarkably equable. The northeast trade winds deposit heavy precipitation upon the windward side of the islands, leaving the leeward side quite dry. Because of this distribution of moisture, vegetation is much more luxuriant on the east than the west slope.

Agriculture.—Like Porto Rico, the Hawaiian Islands are essentially agricultural. On Hawaii, Maui and Oahu there are large areas of deep, fertile soil which has resulted from the decay of the lava. Sugar is the chief crop of the islands, its value being greater than the combined value of all other crops. A large part of the sugar is shipped to San Francisco to be refined.

The pineapple industry has developed rapidly and now ranks next to that of sugar. Coffee, fruits and cocoanuts are grown to some extent. Among cereals, rice ranks first, but because of the large Japanese and Chinese population, nearly all of this crop is consumed locally. Some experiments have been made in cotton growing, and a good quality of fiber has been secured.

Manufacturing.—There is very little manufacturing aside from that growing out of the production of sugar and pineapples. There is no mineral wealth produced upon the islands, and this is a detriment to manufacturing. In the manufacture of sugar, the refuse from the sugar cane is used as a fuel and this results in a considerable saving. Pineapples are canned and shipped to the United States.

History.—Probably the first white men to see these islands were some Spanish sailors who were wrecked here in 1527. In 1778 Captain Cook visited the group, and as early as 1820 American



MAP OF HAWAIIAN ISLANDS

missionaries began to work with the natives. In 1898 the islands were annexed to the United States, and two years later a territorial government was organized.

Cities.—The chief city is Honolulu, which in 1920 had a population of about 80,000. Near the city is Pearl Harbor, a land-locked lagoon 4 by 8 miles in its dimensions and having a depth ranging from 30 to 130 feet. Back of the harbor rise mountains from 3,000 to 4,000 feet in altitude.

As Honolulu is on the southwest coast of Oahu, its rainfall is comparatively light, being about 25 inches per year. On the opposite coast the precipitation is more than twice as heavy. The mean annual temperature is about 75° F.

FIG. 190.—Rainbow Falls near Hilo, Hawaii.

Among the important imports are coal, machinery of various kinds, clothing and food stuffs, most of which are obtained from the United States. Sugar, copra and pineapples are important exports. Because of the position and ownership of the islands, the investment of American capital in the sugar plantations and the demand for sugar in our country, practically all of this commodity is shipped to San Francisco.

Population.—The area of the Hawaiian Islands is about twice that of Porto Rico, yet in 1920 the population was only about 250,000. This gave a density of 36 per square mile.

Many nationalities are represented, the Japanese most numerously. This is a natural result of the crowded condition in Japan, the similarity in climate and products and the opportunities for unskilled labor on the plantations. In 1920 Japanese made up 44 per cent. of the total population of the islands.

Many Chinese, Koreans and Filipinos have taken up their residence in the Hawaiian Islands. In 1910 the white population was 23 per cent. of the total, while the natives amounted to but 14 per cent. According to the census of 1910, more than one-fourth of the inhabitants could not write. Practically the entire population is located upon the four islands of Oahu, Hawaii, Maui and Kauai.

THE PHILIPPINE ISLANDS

General Statement.—It was in 1521, when Magellan was making his famous circumnavigation of the globe, that the Philippine Islands were discovered. They remained in the possession of Spain almost continuously until 1898, when, as a result of our war with that country, they came into our possession. We paid Spain $20,000,000 for the islands, but their exports have since then been worth more than this amount yearly.

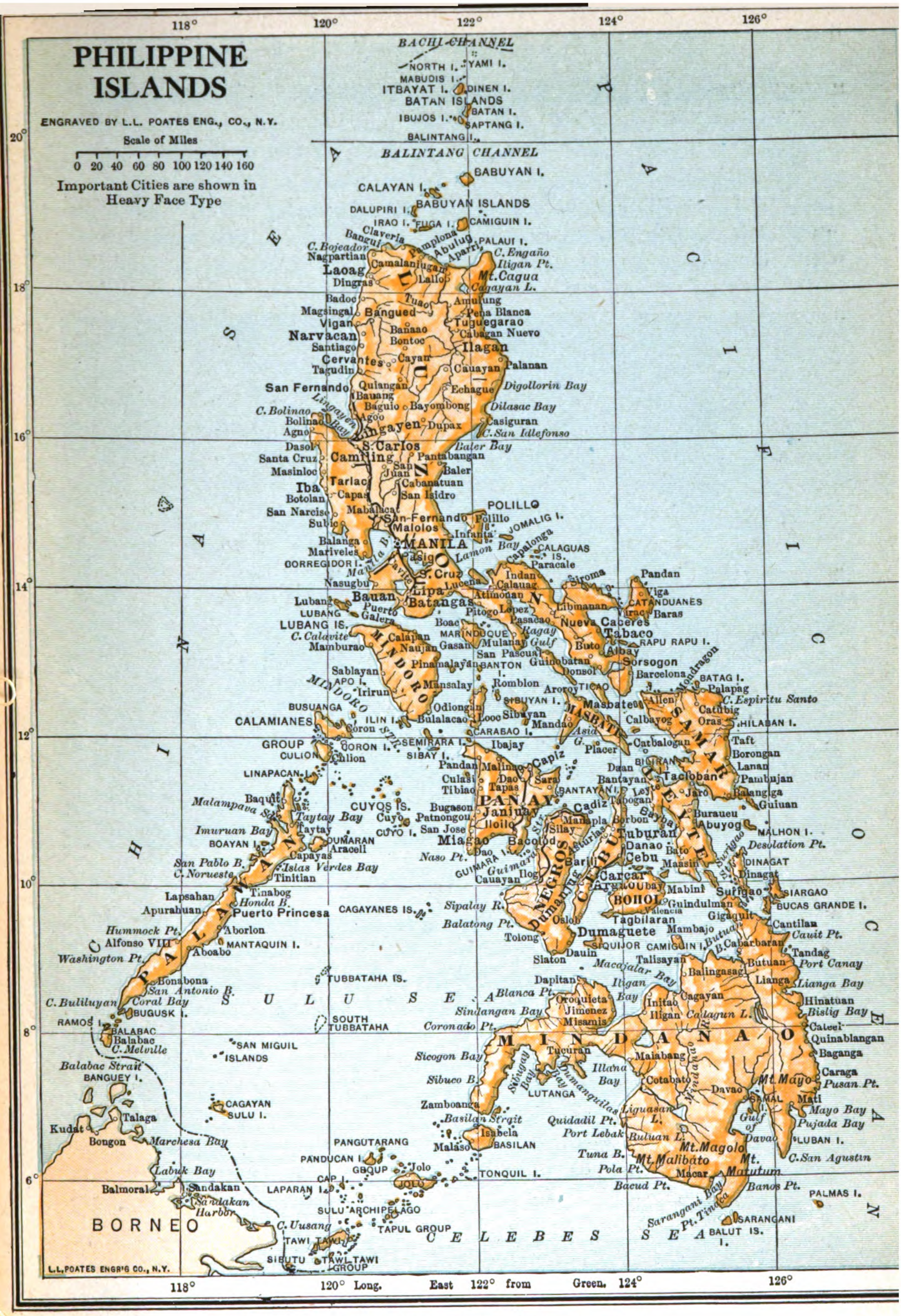
There are some 3,000 islands in the group, most of which are but patches of rock which rise from a great partially submerged volcanic plateau. There are 12 active volcanoes upon the islands, and as a natural accompaniment of volcanic activity there are frequent earthquake shocks and hot springs are numerous.

Climate.—Owing to the latitude, the climate upon the lowlands is tropical. This fact, together with the high humidity, unfits the lowlands for a laboring white class. At higher elevations the climate is delightful.

When summer prevails in the southern hemisphere the northeast or dry monsoon blows. With the transference of the greatest heat to the northern hemisphere, there is a shift to the southwest or wet monsoon. During the change from the one to the other there is a period of variable weather.

Weather conditions are influenced by the typhoons and violent thunderstorms. The former are most prevalent in the autumn, because then the surface waters of the ocean have reached their highest temperature and the superimposed layer of atmosphere is warm and light. The thunderstorms occur chiefly during May and June. The average annual rainfall at Manila is about 50 inches.

Forests.—The two essentials for a luxuriant vegetation—high temperature and abundant moisture—being present, forests abound. From these forests in years to come there will be obtained much lumber to be used in furniture and cabinet making. The lack of roads, the long distance from markets and the hardwoods yet remaining in the United States prevent their present exploitation. The rubber tree, trees which have a medicinal value and others valuable in the making of dyes are numerous. One of the most useful plants, a tree in appearance but in reality a grass, is the bamboo, which the natives use for a variety of purposes.



MAP OF THE PHILIPPINE ISLANDS

Agriculture.—The products of the soil in the Philippine Islands will always be those of chief value. The lowlands are well adapted to rice, which is the staple food of the natives. Much of the labor on a rice plantation is performed by hand and the remainder by the carabao. A few years ago the rinderpest caused the death of about 90 per cent. of the carabao, and this, together with the ravages of the cholera, so reduced the production of rice that famine resulted.

FIG. 191.—Cocoanut grove at San Ramon, Zamboanga, P. I.

Through the appropriation of money by Congress these conditions have been remedied.

Tropical and subtropical fruits are grown extensively. The banana, plantain, orange, pineapple and guava are some of the more important ones.

Manila hemp is the chief export of the islands. Great quantities of this are sent to the United States. Since 1917 the exportation of cocoanut oil has assumed great importance. Before that date most of the cocoanut exported was in the form of copra. The demand for the oil has led to the planting of large numbers of cocoanut trees. Other exports are sugar, tobacco, copra and lumber. The farms are generally small, for the climate is not such as to encourage or require strenuous labor. It is evident that the products of the soil are, in the main, those not adapted to large areas in our country, and therefore their value to the United States proper is very great.

Mineral Wealth.—Apparently there is considerable mineral wealth, but it has not yet been extensively developed. Both coal and iron appear to be widely distributed, but there is comparatively little local demand for coal for heating purposes and manufacturing is not important. As a result of these conditions only a small amount of coal is mined. Gold, silver, copper, sulphur and lead are produced in small quantities.

Cities.—Manila, the commercial center of the Philippine Islands, is situated on the southeast shore of the extensive land-locked bay of the same name. The six-mile-wide entrance guarded by the island of Corregidor opens to the west, and this allows the southwest monsoon to sweep the bay. The government has expended much money for the improvement of the harbor.

Manila is the center of the railroad system of Luzon, and is connected with all of the provinces by telegraph and with San Francisco by cable. As the city is only about 10 feet above sea level the problems of drainage and water supply have been difficult to solve. Water is now obtained from the mountains some 15 miles distant.

The Pasig River, a short sluggish stream, flows through the city. Large quantities of cocoanuts are rafted down the river to Manila, and along its entire course there are villages, gardens and duck farms.

People.—The total area of the Philippine Islands is only a little greater than that of Colorado, and yet its population is more than 8,000,000. Most of the people belong to the Malay race, although there are some negritos left. The Filipinos are a teachable people and the schools are doing much for their advancement. In addition to the native teachers, large numbers of American teachers are employed in the public schools. The primary purpose is to give such instruction as will enable the people to become self-supporting and reduce the high death rate, especially among children.

OUR SAMOAN POSSESSIONS

Far to the westward of the Hawaiian Islands are the islands of the Samoan group. Several of these came into the possession of the United States in 1899. The largest and the most important of our Samoan islands is Tutuila, the value of which depends chiefly upon its excellent harbor.

Tutuila has its greatest extent from east to west. The eastern half is but two or three miles in width. The island is of volcanic origin and is quite mountainous. In the warm shore-waters coral reefs have been built, and against these the waves pound unceasingly.

The southeast trade is the prevailing wind and it brings an abundance of rain to the island. As a result of this and the high temperature tropical vegetation clothes the land. The graceful cocoanut, the banana and the breadfruit tree are common. As in China, Japan and the Philipppines, the bamboo is used for a variety of purposes. The taro, sweet potato and rice are grown. Copra is the only export.

The harbor of Pago Pago is the water-filled crater of an immense volcano. Its narrow entrance is on the south, and the harbor is therefore well protected against the prevailing winds and storms.

GUAM

Some 1,500 miles east of Manila is the island of Guam, which was ceded to the United States by Spain in 1898. Its importance is derived from the fact that it is a landing place for our Pacific cable, a coaling station and a naval base. Guam is the largest island of the group, to which Magellan in 1521 gave the name of Ladrones (or "thieves") islands because the natives stole one of his rowboats.

Owing to the small size of the island its climate and weather are remarkably uniform. The mean annual temperature is about 80° F. The vegetation is of course tropical. The rice grown is chiefly consumed locally. Corn is a very important article of food and copra is exported. Our government has established an experiment station the work of which has already been of great value to the natives, who are an agricultural people. The chief port is San Luis de Apra on the west coast.

THE CANAL ZONE

At two places nature joined continents in a manner very unfavorable to ocean commerce. At the east end of the Mediterranean Sea a land bridge connected Asia and Africa, and North and South America were connected by the Isthmus of Panama.

Until 1869 the water route between Europe and Asia led around the Cape of Good Hope. In that year the Suez Canal was completed, and this shortened the ocean journey between Europe and the Far East by thousands of miles. Not until 1914 was the Isthmus of Panama pierced by a canal, thus giving to the world a water route which for centuries has been the dream of navigators.

It was the desire to find a shorter route to India, not the hope of discovering a new continent, which led Columbus to make his voyages. Balboa believed in the existence of a strait across the Isthmus

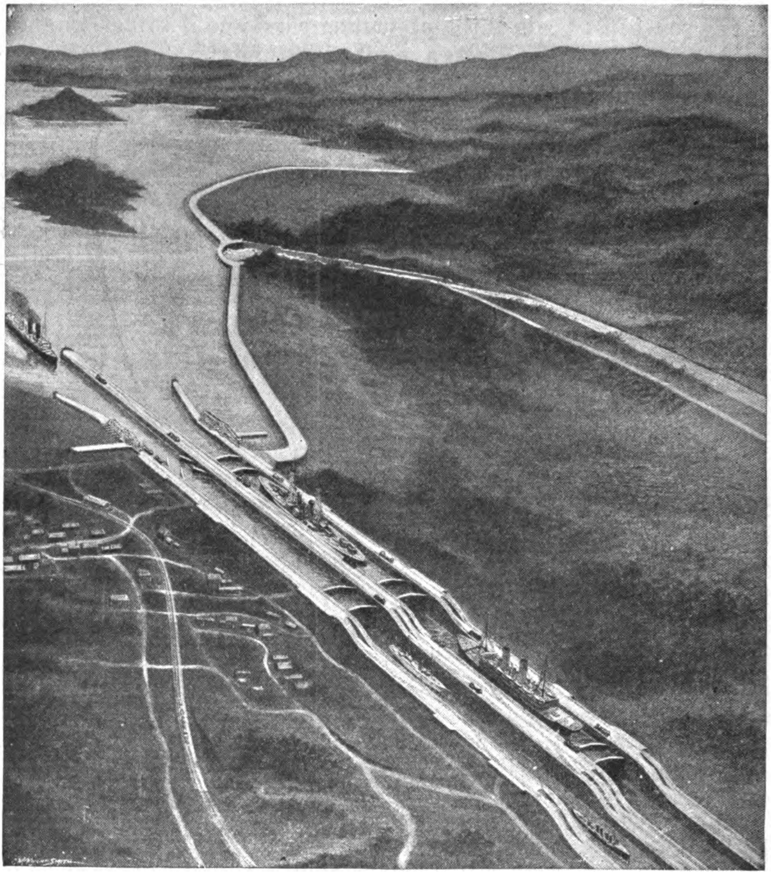
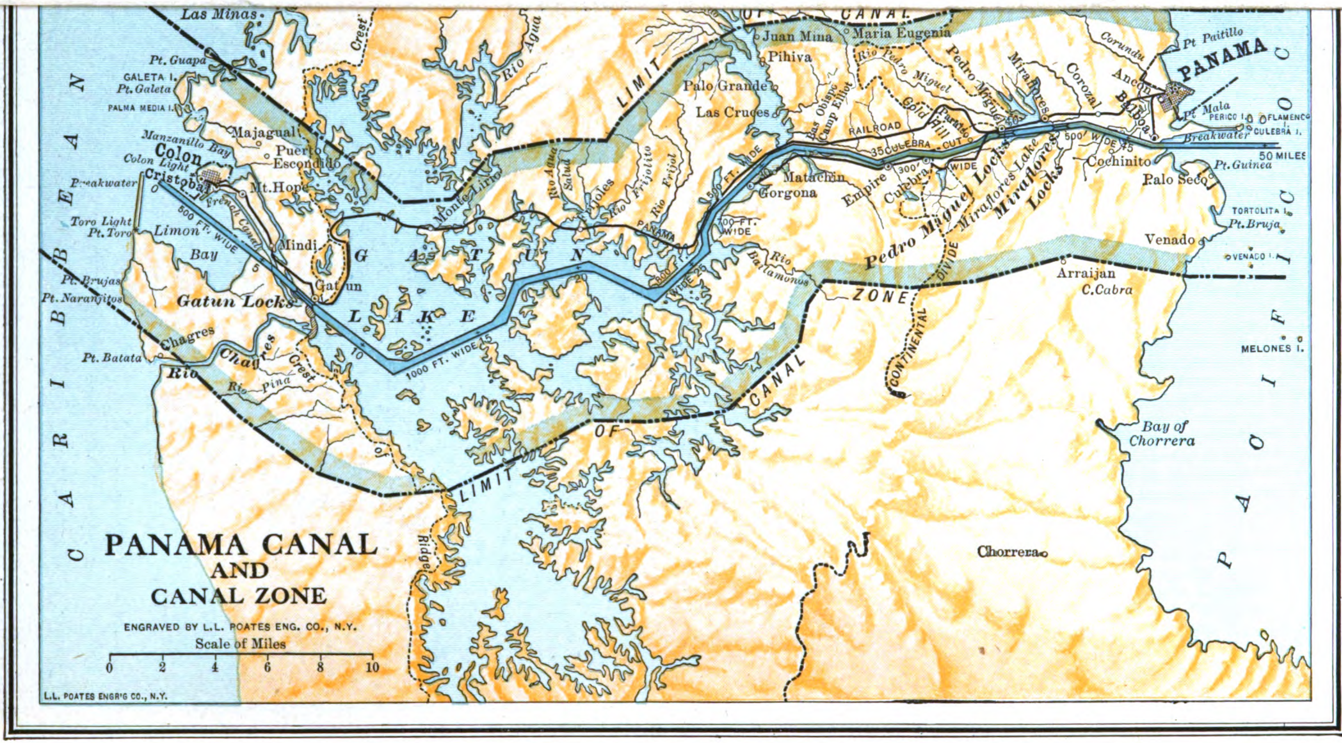


FIG. 192.—Bird's-eye view of Panama Canal locks.

of Panama, and Charles V. sent Cortez to search for such an opening. More than four centuries passed before the dream of Columbus was realized, however.

A study of a map of the Western Hemisphere shows that the ocean route from New York City to San Francisco by way of Cape Horn



MAP OF PANAMA CANAL ZONE

is about 8,000 miles longer than the route by way of the Panama Canal. This makes the importance of the canal apparent.

About 1850 the United States, because of its acquisition of territory in the far West, began to realize the need of a shorter route between the Atlantic and the Pacific seaboards. The construction of a canal was hindered by our foreign relations. Then came the Civil War, and before we were ready to undertake the excavation of a canal the French had commenced to work.

In 1878 France secured a concession from the government of Colombia, and the next year the Panama Canal Company was organized with Ferdinand de Lesseps as its president. After ten years of labor, the expenditure of an enormous sum of money and great loss of life, the company went into bankruptcy.

The people of the United States had not been entirely inactive, however. In 1850 permission was secured from Colombia, then called New Granada, to build a railroad across the Isthmus of Panama. This road was completed in 1855 at a cost of about $7,000,000. It has done, and is yet doing, a large amount of business.

In 1901 a committee, which had been appointed by our government to make a study of the most desirable routes for a canal, reported in favor of the Panama route. The next year Congress authorized the President to purchase from the Panama Canal Company all of its property and rights for the sum of $40,000,000.

Before the negotiations between the United States and Colombia were completed, Panama, then a state of that republic, rebelled. It was recognized by the United States and other nations as an independent power. Our government secured from this new republic a strip of land ten miles wide lying on each side of the proposed canal route. This is now known as the Canal Zone.

Before the work of constructing the canal could with safety be commenced, the country had to be rendered safe from a sanitary point of view. This was a tremendous undertaking and required practically two years.

The map shows that the Isthmus of Panama extends in a general east to west direction, hence the course of the canal is, roughly, from north to south. The Pacific end of the waterway is about 20 miles east of the Atlantic end.

The canal is approximately 45 miles long, and about 15 miles of the total is at sea level, about one-half of this being at each end. From Limon Bay, on the Atlantic side, ships follow a sea-level route to Gatun. Here they are raised by locks to Gatun Lake, 85 feet above the level of the sea. At Pedro Miguel are locks where a corresponding lowering takes place.

The continental divide is penetrated by means of the Culebra Cut. This cut was a most difficult and costly piece of work, and from time to time since the opening of the canal business has been temporarily suspended because of slides.

Although the Canal has been in operation but a few years, an enormous volume of commerce passes through it. This amounts to several million tons annually, and requires a large number of vessels. The chief commodities are nitrates, sugar, coal, refined petroleum, grain, iron and steel goods and lumber. The coastwise trade of the United States is more important than that of any other passing through the canal. Next in importance is the commerce between Europe and the western coast of the Americas.

During the month of March, 1915, the Panama Canal handled more freight than did the Panama Railroad during the year ending June 30, 1915. If this railroad had transported the freight which was shipped by the canal, more than 14,000 trains of 18 to 20 cars each would have been required.

As the Canal Zone is within the tropics, and as its elevation is nowhere great, it has a tropical climate, and a wealth of tropical vegetation. The temperature varies from 90° F. during the day to 70° F. during the night. The rainy season lasts from May to January. As no settlement is to be permitted within the Canal Zone it will rapidly revert to jungle conditions.

Our frontage upon two oceans makes the Panama Canal of vast importance to us, and our distant possessions furnish another important reason why we should be in control of the canal. This waterway stands as one of the greatest of human achievements. It is an illustration on a gigantic scale of man's response to geographic environment. Here a barrier to human progress has been overcome, and in the overcoming man has made full use of such advantages as nature offered.

STUDIES

What conditions favor agriculture in Porto Rico? In what ways is Porto Rico valuable to the United States? What retards manufacturing on the Hawaiian Islands? Why is so much of the commerce of the Hawaiian Islands carried on with our country? To what extent will the Philippine Islands furnish desirable homes for white persons? In what way does each of the following areas benefit by the Panama Canal: The Atlantic Coast of the United States, the Pacific Coast of the United States, Peru, Brazil, the British Isles?

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