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AN INTERMEDIATE COMMERCIAL GEOGRAPHY

PART I

COMMODITIES AND WORLD TRADE

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By L. DUDLEY STAMP, D.Sc., B.A.

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With Maps and Diagrams

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AN INTERMEDIATE COMMERCIAL GEOGRAPHY

BY

L. DUDLEY STAMP, B.A., D.Sc., F.R.G.S.

SIR ERNEST CASSEL READER IN ECONOMIC GEOGRAPHY IN THE UNIVERSITY OF LONDON AND DIRECTOR OF THE LAND UTILISATION SURVEY OF BRITAIN

PART I

COMMODITIES AND WORLD TRADE

WITH MAPS AND DIAGRAMS

NINTH EDITION

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PREFACE

ONE of the most difficult stages in an educational career is the transition from school to university. It is true that there is not now quite the same sharp contrast as there was formerly between the rigid discipline of the school class-room and the freedom of the lecture-room, or between the orthodox lesson and the frequently almost heterodox lecture. Usually, however, there is a fundamental difference of outlook between the schoolmaster and the university professor which is reflected in varying degrees in the student. Whatever our educational system, it is but right that a large proportion of our schooldays should be devoted to the acquisition of facts: to the schoolboy the printed word of the text-book is above suspicion; it is accepted without question as the truth and stands thus as necessary knowledge to be acquired. It comes almost as a shock to the young university student to find text-book dogmas doubted or even ridiculed, statements questioned and others classed as old-fashioned.

Armed with a sound knowledge of facts, the university student should be in a position to develop a broader outlook, a critical faculty, and a capability of bringing his knowledge up to date from sources outside the text-book.

This book has been written with the object of bridging the gulf. It is, as far as possible, self-contained, but assumes a certain knowledge of ordinary geography as taught in schools. The first part breaks away from the bonds of political boundaries and attempts to treat of the essentials of economic geography on a world basis, that is, on a basis of commodities and world trade. Within the modest compass of a text-book intended for university students who have probably three or four other subjects to consider it seemed impossible to deal with the regional geography of the whole world and then to add thereto further details of foreign trade. The second part of the book gives, therefore, a brief recapitulation of the main aspects of the regional geography of the continents to serve as a foundation for the consideration of the economic or commercial geography of certain of the more important countries of the world. The selection of countries may seem arbitrary and is obviously open to criticism, but it must be borne in mind that all the countries of the world have been taken into consideration in Part I.

The book is intended for use mainly in the great English-speaking countries of the world. For that reason the treatment of the United States and the integral parts of the British Empire has been made rather more complete than in the case of other countries.

Students are often greatly confused by the varying units adopted in expressing quantities and values. With a few exceptions metric tons, gold dollars, and pounds sterling have been used throughout, but factors for conversion into all the common units will be found in their appropriate places.

The writer on economic geography, in common with all writers on economic subjects, is rather in the position of the girl pillion rider who, in the course of a joy ride, exclaims to her pilot, " This is a pretty village, wasn't it ? " A text-book is no sooner written than it is liable to become out of date. While the text-books are bemoaning the coming cotton famine, based on the registered decline in 1914–1923, the world outside is faced with the stupendous over-production of 1926. Every effort has been made to prevent this book from becoming out of date by indicating to the student where the latest information or most recent statistics may be found. This serves the triple purpose of keeping the book always up to date, giving the student a valuable exercise, and acquainting him with the original sources. At the same time the first year at a university is a crowded one, the student has only a limited time for each subject. The graphs, diagrams, and tables in this book have, therefore, been constructed, purposely, from a strictly limited number of sources so that the student is brought into contact with a small but very important series of source books. Thus in Part II the diagrams for foreign trade have been drawn up from information published annually in the *Statesman's Year Book* or the *Annual Reports on the Balance of Trade* (League of Nations), because both are important works of reference which should be familiar to all students. At a later stage, the more advanced student, on the other hand, would naturally consult the statistical publications of the countries concerned. In this connection it may be noted that the present volume forms a natural introduction to Chisholm and Stamp's *Handbook of Commercial Geography* (Longmans).

This book has been written to meet the needs of the present-day student, the test questions and exercises have therefore been selected from examination papers set in recent years by various universities and other educational bodies. For permission to reproduce such questions, I am indebted to the requisite authorities in the Universities of Alberta, Bristol, British Columbia, Harvard, Lahore, Leeds, Liverpool, London, Oxford, Rangoon, Sheffield, Toronto, and West Ontario. Certain questions have also been reproduced with the sanction of the Controller of H.M. Stationery Office.

No apology is tendered for the inclusion of matter in this book which purists may regard as not strictly "geographical." The rigid delineation of subjects is surely a remnant of the past and certainly far from conducive to progress.

In the details of the preparation and publication of this book, I have been ably assisted by Miss D. M. Fisher, B.A., whose help is gratefully acknowledged.

L. DUDLEY STAMP.

LONDON SCHOOL OF ECONOMICS,
November, 1927.

NOTE TO THE SEVENTH EDITION

This edition owes not a little to my good friend Mr. B. B. Dickinson who, in thoughtful and constructive criticism, has given me the fruits of his several years' experience in using the book. Miss H. H. Barnes has also helped me in the same way and may I say to all my readers, *o si sic omnes.*

L. D. S.

June, 1936

NOTE TO THE NINTH EDITION

In this edition nearly all the world production diagrams have been brought up to the end of 1938 and show not only the emergence of the world from the Great Depression, but the possible incidence of a new one. Some of the students and teachers who have used this book have found the treatment of physical geography insufficient for their needs. This is particularly the case with those studying for examinations in Science or Arts. It would have added too much to the bulk and cost of this book to have given an adequate treatment of the aspects of the subject concerned, so I have prepared a separate book, fully illustrated, entitled "Physical Geography and Geology."

L. D. S

March, 1939.

The statements in this book refer to conditions as they were before the outbreak of war in September 1939.

L. D. S.

November. 1943.

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AN INTERMEDIATE COMMERCIAL GEOGRAPHY

CHAPTER I

MODERN GEOGRAPHY

In books of a generation ago geography is frequently described as "a description of the world and its inhabitants." Unfortunately geography is still regarded by many to-day merely as a descriptive catalogue. However justified such a conception may once have been, it is no longer true. It has been said that geography is at once a science, an art, and a philosophy. Perhaps we gain the clearest conception of what modern geography embraces if we regard it as a concrete philosophy. It is, indeed, the cream of a number of sciences carefully blended. The geographer uses certain of the results of such sciences as geology, meteorology, oceanography, anthropology, sociology, and economics because they concern the environment of his central figure, Man. Therein lies the justification of the common accusation that geography as a subject does not exist. It is perfectly true that if one attempts a detailed investigation in a subject lying in any sector of the ground covered by geography, one is inevitably brought into contact with one of the underlying sciences on which the geographical superstructure rests. That does not invalidate the existence of geography as a complex subject, a philosophy if one will, correlating the results of a number of otherwise unrelated subjects and having as a central theme Man, his distribution, environment, and activities. There are certain branches of geography which deal solely with certain aspects of the environment and are not directly concerned with man. Such branches are usually grouped under the old names of mathematical and physical geography.

Most sciences have started by being purely descriptive. The first essential has been the collection of facts. As the mass of carefully described facts, whether they be of observation or experiment, has accumulated, attempts have been made to formulate laws explaining the results or facts observed. It may be quite candidly admitted that geography has only emerged from the descriptive stage within the present century, and it is not unexpected that memories of the chrysalis stage, as embodied in the school text-books of twenty years ago, still stand for "geography" in the minds of many.

The old geography worked from effect to cause; modern geography works from cause to effect. We shall therefore consider primarily in this book the principal factors which tend to control the distribution and activities of man.

Of these factors the plan of the earth, or the configuration and relief of the lands and the climates of the world are the two foremost. They so far influence as practically to control the distribution of natural vegetation and animals and, usually also, provide the limiting factors to man's activities. We shall therefore consider, very briefly, the plan of the earth and its climates before dealing with the commodities of commerce.

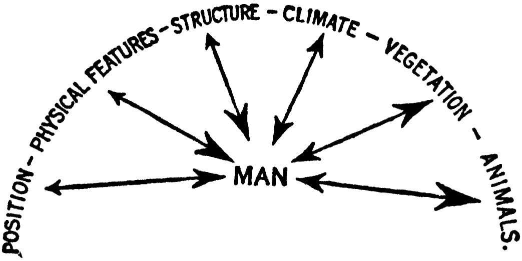
POSITION - PHYSICAL FEATURES - STRUCTURE - CLIMATE - VEGETATION - ANIMALS.
MAN

Fig. 1.—Diagram showing geographical "control" or influence.

The physical features of the earth's surface depend to a large extent on the underlying geological structure. The rocks and climate together determine the soil, and so physical features, structure and climate may be said to determine the natural vegetation, the natural vegetation determines the types of animals The activities of man are determined by all these factors, but remember he is able to overcome some of them, at least in part For this reason the idea of a strict geographical "control" should give place to a proper appreciation of the importance, actual and relative, of the influence of each geographical factor.

CHAPTER II

THE STRUCTURE OF THE EARTH

The Structure of the Earth.—Scientists have now reached fairly general agreement on a number of major points concerning the structure of the earth. The density of the earth as a whole is about 5·5—that is, its weight is 5½ times as great as an equal volume of water; whereas the average density of the rocks composing the earth's crust is only about 2·5. The centre of the earth is therefore believed to consist of a solid mass having a density of about 7.

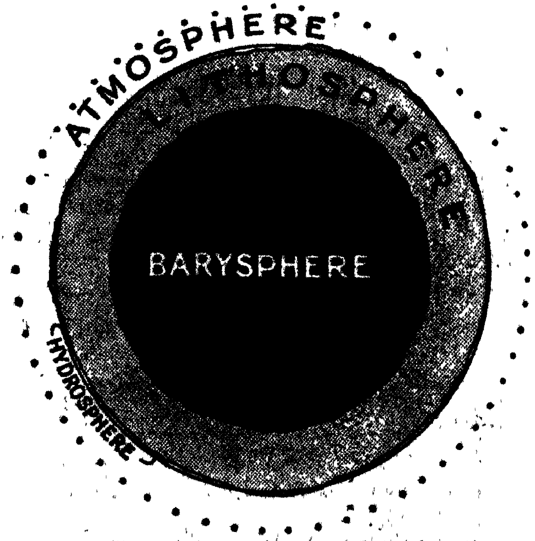

FIG. 2.—The constitution of the earth.

From a study of the magnetic properties of the earth and by a comparison with the composition of meteorites, this central, heavy "barysphere" is believed to consist mainly of metallic iron, probably with an admixture of nickel and other metals. It should be observed that the old idea of the earth having a liquid or molten interior is now almost universally rejected as impossible.

Surrounding the metallic barysphere is the earth's crust or "lithosphere." There is considerable difference of opinion regarding the thickness of the crust, but 700 miles is commonly accepted as an approximate figure. It is only possible to see and study the surface layers of the lithosphere, but it is a well-known fact that the temperature steadily increases as one goes downwards in the crust—as, for example, in a mine. At great depths it must become so hot that the rocks, if they could, would be molten. For the most part, however, the rocks are kept solid because of the great pressure. The solid earth's crust can therefore be pictured as a thin, solid shell below which the rocks are very hot indeed. But the shell is not equally strong all over. The lines of weakness are often marked by great cracks or "faults" or by chains of mountains. Such zones of weakness occur especially where high mountains and deep sea troughs are found in close proximity. Where the crust becomes weaker by the wearing away of the surface, the pressure it exerts on the underlying layers may become less; with the result that the heated rocks below become molten and begin to move. The movement of molten rock underground results in earthquakes. Sometimes the molten rock finds its way to the surface and is poured out as lava from a volcano. Notice that the volcanoes of the world are arrayed definitely in lines corresponding with lines of weakness in the earth's crust. In other cases the molten rocks do not actually reach the surface but consolidate some distance below, though such "plutonic rocks" may

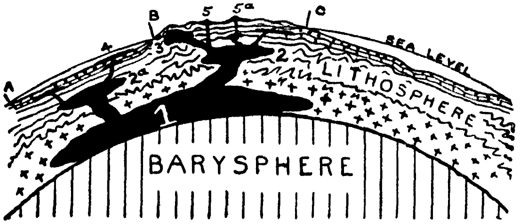

FIG. 3.—Diagrammatic section through the earth's crust.
(From Stamp's Stratigraphy (Murby & Co.).)
1 = a great mass of molten rock deep down in the earth's crust; 2 and 3 = smaller masses of molten rock; 4 = lava poured out under the sea; 5 and 5a = volcanoes.

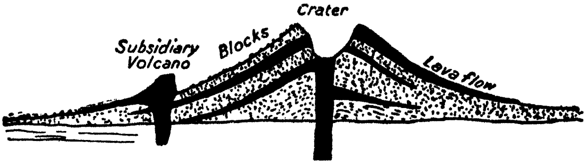

FIG. 4.—Diagrammatic section through a volcano (Mount Popa, Burma).

afterwards be exposed by the wearing away of the overlying crust. To the economic geographer the plutonic rocks, of which granite is an example, are of special importance, because the molten rocks bring up with them in solution the valuable ore minerals. Most ore bodies are associated either with the edges of plutonic masses, or with the rocks infilling cracks leading from the masses towards the surface (*i.e.* lodes).

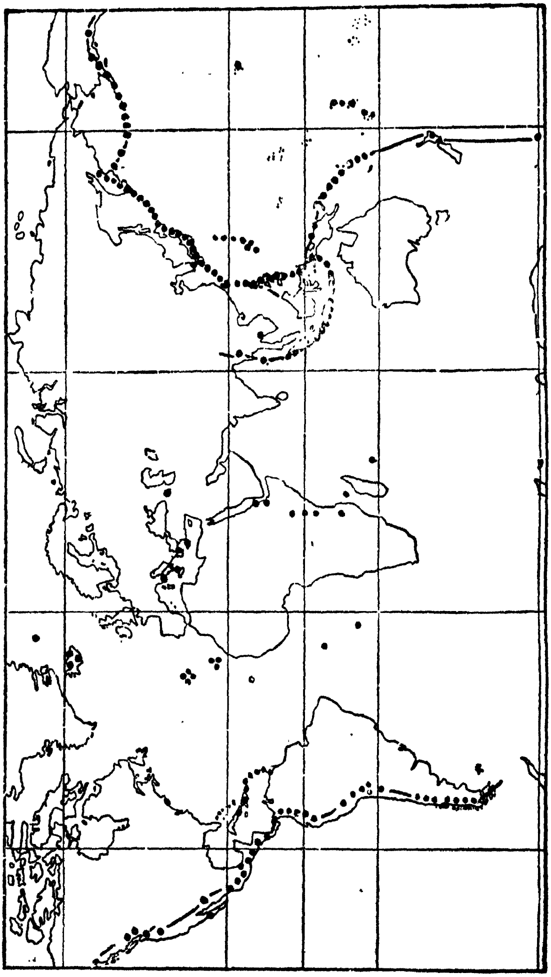

Fig. 5.—Map of the World showing the distribution of volcanoes (marked by dots).

The earth's crust may be considered, very broadly, as consisting of relatively stable, solid blocks, separated by zones of weakness, resting on a lower layer which is either molten or in a plastic condition. Those parts of the crust lying in the zones of weakness are subjected to severe strains, and it is there that the rocks are folded, twisted and torn and the great mountain chains are built up. Of recent years there has been considerable discussion as to whether the relatively stable continental blocks remain in the same positions or "drift" relatively to one another. Wegener's now famous hypothesis of continental drift presumes that they have drifted apart gradually during the long ages of geological time.

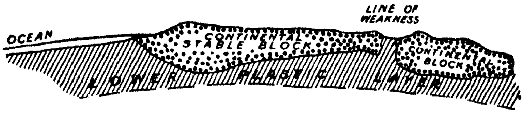

FIG. 6.—Hypothetical conception of the structure of the earth's crust.

Changes on the Earth's Surface.—We have mentioned the changes in the earth's crust—the intrusion and extrusion of molten rocks, the folding and faulting (cracking) of the surface layers, all of which are a result of the internal constitution of the crust. We cannot here consider in detail the changes which are continually taking place on the surface of the earth itself, except to note that the changes fall into three groups.

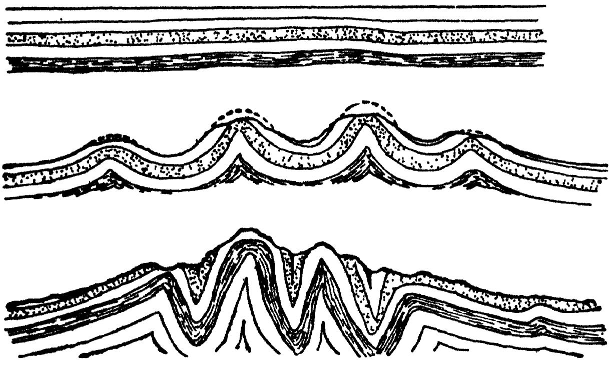

FIG. 7.—Diagram showing three stages in the growth of folds.

The first (top) shows the sedimentary rocks as laid down, almost horizontal. In the second stage they have been folded into a series of anticlines (arches) and synclines (hollows), and the crests of the folds have been denuded away. The third stage shows a section through a range of fold mountains, partly worn away.

There is, in the first place, the wearing away or denudation of the surface. As soon as any portion of the crust rises above the level of the floor of the ocean it becomes subject to the action of various agents which seek to wear it away. The principal denuding agents are the sun, wind, rain, frost, running water, moving ice, and the sea. For an account of the processes of denudation reference should be made to text-books dealing with the physical aspects of geography.

In the second place there is the transport of the denuded material from one part of the earth's crust to another, carried out especially by the action of running water, the wind, the sea, and moving ice.

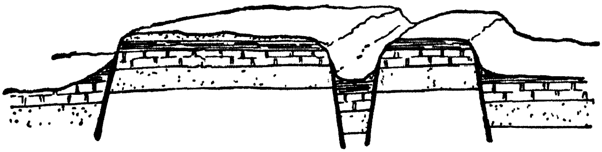

FIG. 8.—Diagram of block mountains and rift valleys.

In the third place there is the deposition of the material which has been worn away from one area and transported to another. The material is usually laid down in layers and gives rise to what are called Stratified or Sedimentary Rocks.

The Classification of Rocks.—The geologist and geographer designate as rocks all materials naturally making up part of the earth's crust, independently of whether they are hard or soft. A distinction is usually made between "rocks" and "minerals"; a mineral having a definite chemical composition, or one varying within narrow limits, whereas a rock usually consists of an admixture of minerals in irregular and varying proportions. Two clear examples of rocks are granite, which consists of the minerals quartz, felspar, and mica with others in smaller proportion; and sandstone, which consists of rounded grains of quartz and other minerals held together by some cementing material. Some rocks, it is true, do consist almost entirely of one mineral. Of such limestone —mainly calcium carbonate—is an example.

It is usual to distinguish five main groups of rocks:

(*a*) Eruptive or igneous rocks, originating as molten material deep down in the lower layers of the crust and of which there are two main groups—

- (i) Extrusive or volcanic—poured out upon the surface;
- (ii) Intrusive, or intruded into the upper layers of the crust. The larger masses are further distinguished as "plutonic."

(*b*) Sedimentary, clastic or stratified rocks, consisting of fragments of other rocks worn away, transported and redeposited in layers. Sand, sandstone, clay, and shale are examples. Of special importance to the geographer is the rock known as alluvium. Alluvium consists of the fine, unconsolidated silt and mud brought down by rivers and distributed over their flood plain or forming their delta.

(*c*) Organically-formed rocks, consisting entirely, or almost entirely, of the remains of parts of organisms. Chalk, consisting mainly of the minute shells of foraminifera, is an example, and a good many other limestones belong to this group. Coal consists of the remains of vegetable material. Rocks of this group usually occur interbedded with sedimentary rocks and some organic remains are commonly found as "fossils" distributed through sedimentary rocks.

(*d*) Chemically-formed rocks, consisting almost entirely of rocks deposited from solution in water. This is only a very small group of rocks.

(*e*) Metamorphic rocks, signifying rocks which have been "changed." Reference has been made to the heated lower layers of the crust. Bed upon bed of sedimentary rock may result in the lower beds coming within the influence of this great heat; folding movements may push down certain layers of rock. By heat and pressure the rocks, not only sedimentary but all others, become hardened and altered until the minerals of which they consist may be completely recrystallized. Such hardened or recrystallized rocks are called metamorphic rocks. Gneiss, schist, marble, and slate are examples. Most of the very ancient stable blocks of the earth's crust, such as the Laurentian Shield, the Deccan of India, the Highlands of Scotland or the plateau of Western Australia, consist of metamorphic rocks.

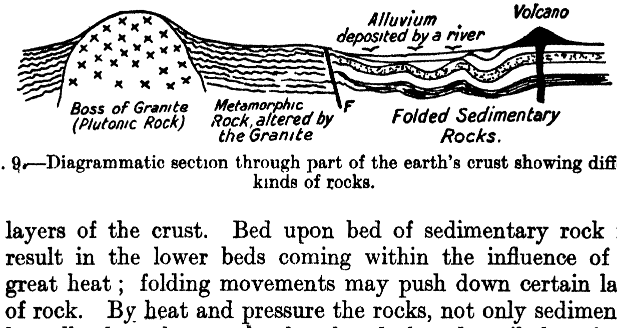
Alluvium deposited by a river
Volcano
Boss of Granite (Plutonic Rock)
Metamorphic Rock, altered by the Granite
F
Folded Sedimentary Rocks.

FIG. 9.—Diagrammatic section through part of the earth's crust showing different kinds of rocks.

Economic Minerals.—There is a definite association between minerals of economic importance and the main groups of rocks. Thus practically all the metallic minerals are associated with igneous and metamorphic rocks. Some iron ores belong to this group (especially the purer iron ores); other iron ores are sedimentary rocks. Coal and oil are always found amidst sedimentary rocks. Some of the more stable minerals such as metallic gold, tin ore, and gemstones may be washed out by natural agencies from the igneous or metamorphic rocks and may be redeposited amongst the sedimentary rocks. Frequently, however, they have travelled but short distances; being heavy they tend to be concentrated in beds not far from their source. Alluvial gold and "stream" tin are good examples.

Geomorphology.—The relief of the lands reflects, in a very marked degree, the underlying geological structure. The harder rocks—igneous, metamorphic, and the older sedimentary—tend to give rise to hilly or mountainous country. Some of the great blocks of ancient rock have, however, been exposed so long to the denuding agents that they have been worn down into almost level plains. The Laurentian Shield is an example. The harder rocks frequently yield but a poor soil and agriculture may be difficult. Mining and forestry are often more important in such areas than agriculture. The younger sedimentary rocks, on the other hand. are softer, are more easily denuded, and break down more easily into rich fertile soils. Less rugged country is the rule, frequently with agricultural and pastoral farming as leading industries, except where the climate is too dry. Alluvium, provided it is neither too dry nor too swampy, almost invariably furnishes rich, fertile soil. Some of the most densely populated regions of the earth are tracts of alluvium, *e.g.* the Ganges Valley.

The study of earth-forms in relation to underlying structure is known as geomorphology.

The Plan of the Earth.—There may have been a time, very early in the earth's history, when the surface of the earth was covered by a uniform sheet of water. There are those who believe that the wrinklings of the surface which result in the present-day distribution of land and water are due to the deformation of the earth from a sphere towards that solid geometric form known as a tetrahedron. They consider that each of the corners of the tetrahedron is represented by stable blocks actually found on the earth's surface and represented by the Laurentian Shield of Canada, the Baltic Shield, Angara Land in North-East Asia, and the continent of Antarctica. Fig. 10 shows the supposed connection. It should be remembered that on the earth, with a diameter of nearly 8,000 miles, the difference in level between the highest peak and deepest ocean trough is only about a dozen miles. There may, therefore be nothing in the tetrahedral idea, but it serves to emphasize one very important fact—the concentration of the land around the supposed "corners" of the tetrahedron, three of which out of the four lie in the Northern Hemisphere.

The oceans occupy about 72 per cent. of the earth's surface, leaving only 28 per cent. land. In other words, the oceans cover more than 2½ times the area occupied by land. Even allowing

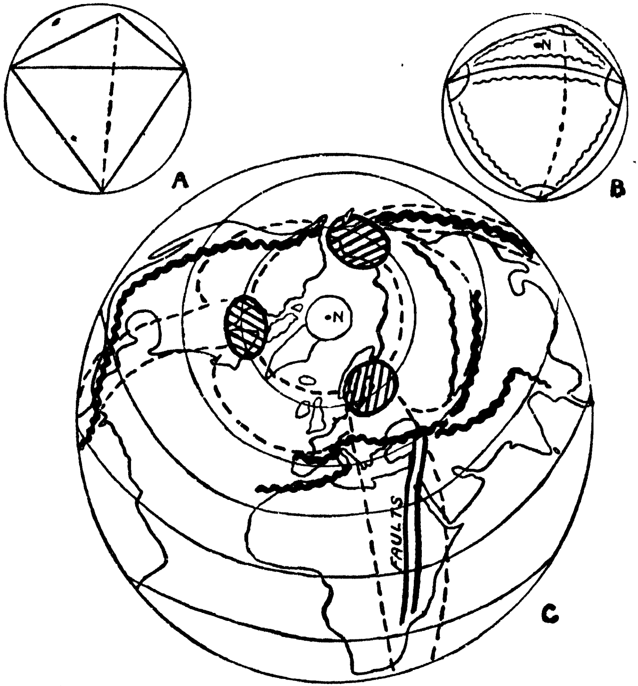

FIG. 10.—Diagram illustrating the "tetrahedral theory" of the deformation of the earth

A. A tetrahedron inside a sphere. B. A tetrahedron with curved faces inside a sphere; The stable corners are shown and the crinkled lines show the theoretical position of lines of folding in the case of a sphere contracting to a tetrahedron. C. A map of the world showing the stable corners of ancient rocks, actual regions of folding (crinkled lines) closely corresponding with the theoretical (dotted).

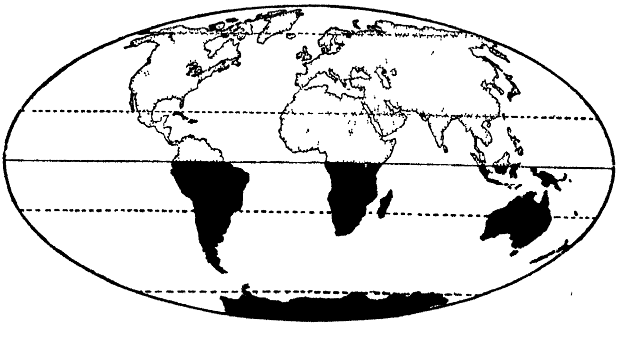

FIG. 11.—Map of the World showing the relatively small proportion of the land surface which lies in the Southern Hemisphere (in black), compared with the area in the Northern Hemisphere (dotted).

for the barren uninhabited continent of Antarctica, nearly three-quarters of all the land surface lies in the Northern Hemisphere. The first point to notice, then, is the concentration of land in the Northern Hemisphere, and the small area of land lying south of the equator.

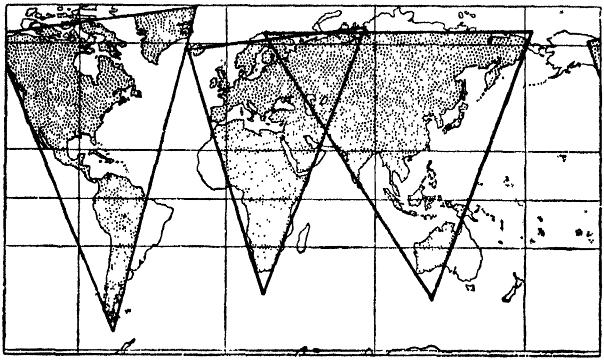

FIG. 12.—Diagram showing how nearly all the land of the globe lies within the area covered by three triangles with their apices in the south.

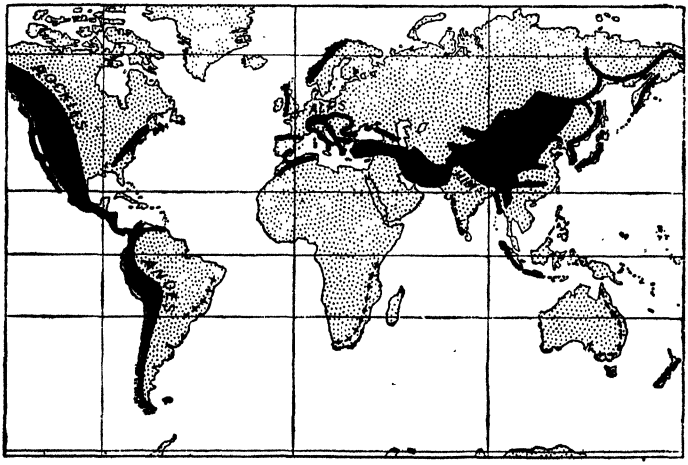

FIG. 13.—The main mountain ranges of the world which act as climatic barriers. In black are the main fold ranges; the lines of crosses show the edges of the great plateaux which act also as climatic barriers.

The second point to notice is that all the great land masses are broadest in the north and taper towards the south. This is true of North America and South America, or of the Americas as a whole.

It is true of Africa; it is true of the Old World—Europe, Asia, and Africa treated as a single mass. The different climatic conditions found in the Northern and Southern Hemispheres, especially the greater lack of uniformity in the Northern Hemisphere, are mainly due to the shape and disposition of the land masses.

In the next two chapters we shall deal with climate, and for the understanding of that section it is essential to bear in mind roughly the shapes of the continents and their disposition relative to the equator and the Tropics of Cancer and Capricorn. We shall deal in Part II with the main physical features of the continents, but it is here important to remember that great mountain chains act as climatic barriers, preventing in particular the free passage of winds. Fig. 13 has been specially drawn to show the main mountain ranges which act as climatic barriers. The great north and south lines in the Americas, the predominantly east and west lines in the Old World, should be specially noted.

Structural Divisions.—Apart from the great belts of fold mountains shown in the last diagram, we can distinguish:

(*a*) The great plateaux, consisting for the most part of vast stretches of ancient, metamorphic rocks. The Guiana Highlands (1), the Brazilian Plateau (2), nearly the whole of Africa (3), Arabia (4), Peninsular India (5), Western Australia (6), China (7), Scandinavia (8), and Greenland (9), are the chief masses.

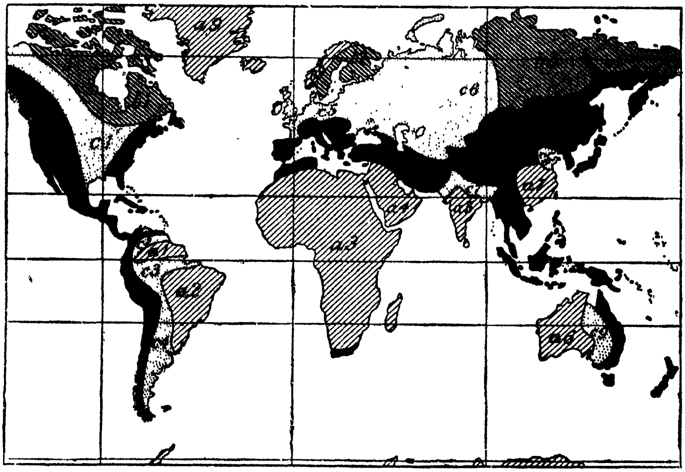

FIG. 14.—The main structural divisions of the world numbered as in the text.
The black area marks the principal belts of fold mountains. Its area is greater than the black area in Fig. 13 because Fig. 13 shows the principal *chains*.

(*b*) The old plateaux, which have been worn down through the ages till they now form lowlands. The Laurentian Shield, the Baltic Shield, and Angara Land are the chief.

(*c*) The great lowlands, consisting mainly of younger sedimentary rocks, in some cases (Amazon lowlands, Northern India) consisting almost entirely of alluvium. Others, such as the North European Plain, are largely broken up by small hills and mountains. The chief areas are the central lowlands of North America (1), the basins of the Orinoco (2), Amazon (3), and Parana-Paraguay (4), in South America, the Great European Plain (5), Western Siberia (6), Northern India (7) (plain of Hindustan or the valleys of the Indus, Ganges, and Brahmaputra), the Great Plain of Northern China (8), and the central lowlands of Australia (9).

These main structural divisions are shown in Fig. 14.

EXERCISES

1. Take any country with which you are familiar and draw two sketch-maps: one to show the main geological divisions—simply the division with the different main groups of rocks will suffice—and another showing the principal mining centres. How far do these maps bear out what is said in the paragraph on "Economic Minerals" above?

2. Study Fig. 14. Write a list of the regions in which you might expect to find (*a*) gold, (*b*) coal, (*c*) oil. By reference to Chapters XI and XII ascertain how nearly correct are your surmises.

EXAMINATION QUESTIONS

1. On an outline map of the world mark in the great belts of young folded mountains. Describe the location of these belts in relation to the continents and oceans; and indicate the characteristic features of their relief and climate. (*Univ. Leeds, 1st Year,* 1927.)

2. How are mountains formed? Give examples and diagrams where possible.

3. Examine the distribution of highlands and plains in the three continents of Europe, Asia, and Africa, and attempt a division of *one* of them into major physical units. (*Univ. London Higher Schools,* 1932.)

4. Illustrate, with the aid of diagrams and by reference to actual examples in the world, the general characteristics of (*a*) ancient plateaux and peneplains, and (*b*) intermontane plateaux of recent origin. (*Univ. London Higher Schools,* 1932.)

5. Classify minerals broadly according to the modes of their occurrence. Note any connections that can be established between the various minerals and the four main types of rock (sedimentary, igneous, metamorphic, organic). (*Univ. London Higher Schools,* 1932.)

6. Divide either the continent of Europe or the United States of America into broad physical regions and describe the relief of any one of your divisions in such a way as to show how it has favoured or hindered economic development. (*Univ. London Inter. B.Sc.* (*Econ.*), 1934.)

CHAPTER III

CLIMATE AND WEATHER

One of the most important, probably the most important, of all the geographical factors influencing the distribution and activities of man is climate. Scarcely a moment's reflection is necessary to note that the frozen wastes of polar regions and the impenetrable forests of the Amazon are alike the results, in the main, of climate—the one of extreme cold and the other of constant heat and moisture. The climatic differences between the south-east of England and the north-east of Germany, or between the Prairie Provinces and the Maritime Provinces of Canada, though less marked than those between the Amazon and polar regions, are none the less of funda-

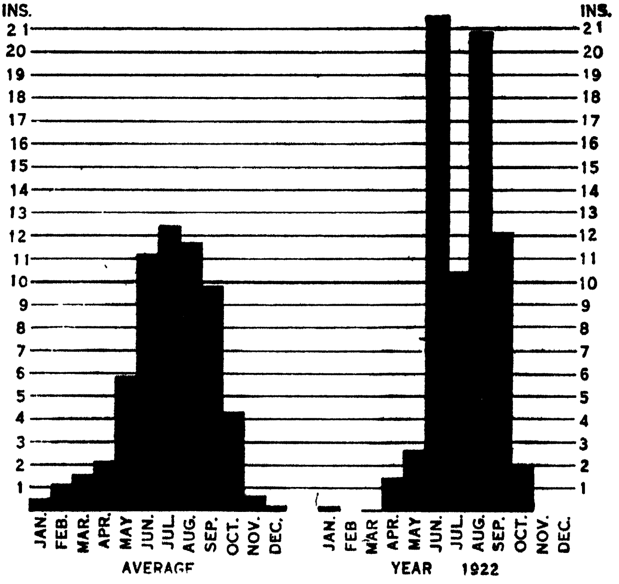

Fig. 15.—The rainfall of Calcutta in 1922, showing departure from the normal or average.

Although the rainfall for the single year was irregular, notice that it is of the same general *type* as the average, the heaviest rain falling in the summer.

mental importance in determining not only the natural vegetation and general characters of the country, but also to a very large extent the economic development.

Climate is frequently defined as the average state of the weather. The phenomena to be considered are the same whether one is concerned with the weather or with the climate of a place ; the difference lies in the length of time considered. Weather refers essentially to short periods—a day, a week, a month or longer ; climate is concerned with average conditions determined by observations made over extended periods.

In countries like England the departure of the weather from normal or average conditions is often very wide, and observations over a limited period such as a year would frequently give very erroneous impressions. In other lands a wide departure from the normal is unusual ; a rainy day in the midst of India's Hot Season is distinctly unusual, whilst a week's scorching sun in Bombay's Rainy Season would be as disastrous as it would be unexpected.

The climates of the world have been classified into a number of more or less distinct types ; but before proceeding to a detailed account of these climatic types and regions it is necessary to understand something of the observations upon which the determination of climatic types is based.

The two factors of prime importance in the determination of climate are temperature and rainfall. Of secondary importance are pressure, winds (strength and direction), humidity, cloud, and sunshine.

The Atmosphere.—The envelope of air or the atmosphere surrounding the earth consists of a mixture of gases. The principal ones are oxygen (about one-fifth of the whole) and nitrogen, which acts as a diluent (about four-fifths). Both plants and animals require oxygen in order to maintain life ; it is absorbed in the process of respiration and in part retained, carbon dioxide being exuded as a waste product. This gas is present in the atmosphere to the extent of 0·02 per cent. Whilst acting as a poison, in large quantities, to animal life, it is absorbed by plants for the purpose of building up their tissues. Various inert gases are also present in the atmosphere in small quantities. Air is very rarely dry, the moisture is present as invisible water vapour. When air contains as much water vapour as it will hold it is said to be *saturated*, or the " Relative Humidity " is 100. When only half-saturated the Relative Humidity is 50, and so on. Warm air can hold much more moisture than cold air, so that if saturated air is warmed it becomes capable of holding more moisture. If, on the other hand, saturated air is cooled the moisture condenses around the innumerable specks of dust always present in the air and appears as cloud or mist ; the drops accumulating fall as rain, hail, or snow according to temperature. The essentials for rain are therefore first, saturated air, and, second, some means whereby that saturated air can be cooled. As shown diagrammatically in Fig. 16 the increase in the holding capacity of air which is warmed five degrees from, say, 80° to 85° F., is very much greater than in air warmed five degrees from, say, 35° to 40° F. Conversely the quantity of water liberated when saturated air at 80° is cooled five degrees is very much greater than if saturated air at 40° is cooled five degrees.

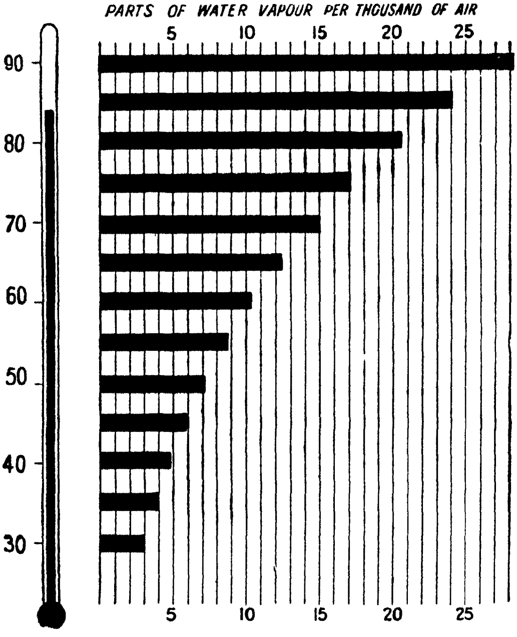

FIG 16.—The water-vapour content of saturated air.

This accounts for the heavy downpours characteristic of the tropics contrasted with the lighter showers of temperate lands.

The Pressure of the Atmosphere.[1]—Unlike most liquids the air, being a gas, is compressible. The atmosphere is, very roughly.

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[1] In this book, English units of pressure, temperature, and rainfall have been used. In the C.G.S., or metric system, Centigrade degrees are used for temperature, millimetres for rainfall and millibars for pressure. Millibars are often used on weather charts showing temperatures in Fahrenheit and rainfall in inches. Conversion.

Temp. in degrees Fahr. $-32°$ multiplied by $\frac{5}{9}$ = temp. in degrees Cent.

Rainfall in inches × 25·4 = Rainfall in millimetres.

Pressure of 30·00 ins. = 1,016 millibars. 1 millibar approximately 0·03 in. The American unit, the kilobar, is the same as a millibar. It should be noted that the millibar is a true unit of pressure, being defined as the pressure of one thousand dynes per square centimetre, whereas a "pressure of 30 inches" is really an elliptical expression for the weight of a column of mercury 30 inches high.

about two hundred miles thick, but the upper limit is almost impossible to define, for in the upper layers the air becomes excessively thin or "rarefied." The lower layers are much denser and heavier. At sea-level the air exerts a pressure roughly equal to 15 lbs. per square inch; a pressure capable of balancing a column of mercury 30 inches high. The pressure of the air is commonly measured in terms of the length of the column of mercury it will counterbalance. Thus, at a height of 15,000 feet the pressure is only about 15 inches; at 30,000 less than 6 inches. The instrument which measures pressure—that is, the barometer—shows that the pressure even at sea-level is constantly changing. Warm air is lighter than cold air; moist air lighter than dry air; hence air which is both warm and damp tends to rise and the pressure in such regions is low. Cold, dry air is heavy and the pressure in such regions tends to be high.

The Temperature of the Atmosphere.—The earth obtains nearly all its heat from the sun. The atmosphere is warmed partly by the passage of the sun's rays through it, but to a greater extent by the heat which, absorbed by the earth's surface, is re-radiated into the atmosphere. This is one explanation why the air is warmer near sea-level than at considerable elevations. The sun's rays do not heat the whole surface of the earth equally. A place which is directly under the sun gets more heat than a place which is sloping away from the sun. At the equator, therefore, where the sun is almost overhead for the greater part of the year, a bundle of sun's rays is only spread over a small area. On the other hand, near the poles, where the sun is never overhead, the same number of rays would be spread over a much larger area. The rays near the poles also pass through a greater thickness of the atmosphere and so lose more heat. This is illustrated in Fig. 17.

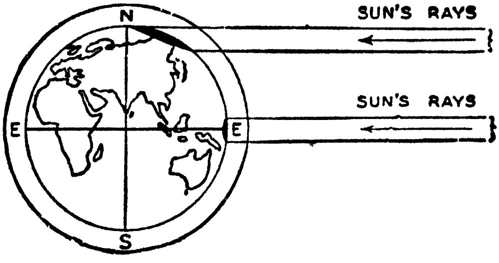


Fig. 17.

Temperature is measured by the thermometer either in degrees Fahrenheit or degrees Centigrade. In this book Fahrenheit degrees will be used.

Observations on temperature are, naturally, of the greatest importance in the study of weather and climate. To secure uniformity, the temperature of the atmosphere is measured in the shade at a height of 5 feet from the ground. Standard types of shelter for the instruments secure ventilation and adequate protection from the sun. Usually two thermometers—a maximum and a minimum—are used. The records are taken every twenty-four hours, and show the maximum and minimum temperatures reached in the preceding twenty-four hours. The difference between the two gives the day's range—that is, the range between day and night

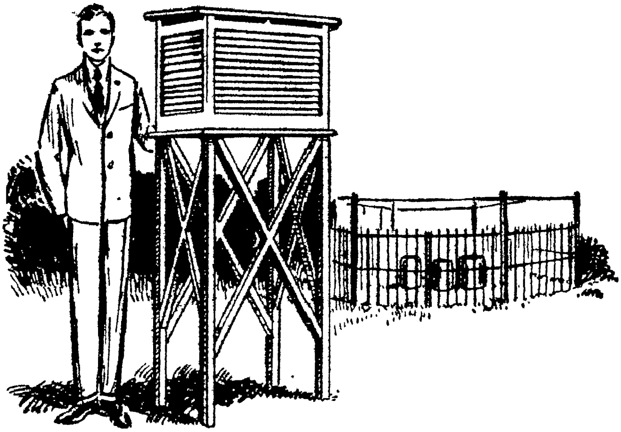


Fig. 18.—Standard form of instrument shelter, with rain-gauges in background.

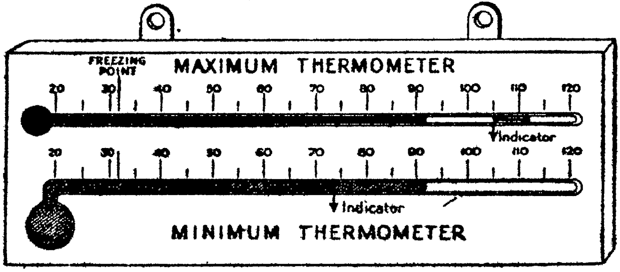


Fig. 19.—Maximum and minimum thermometers.

The maximum thermometer is filled with mercury which pushes along a little glass rod, so that the rod marks the highest temperature reached (here 105°). The minimum thermometer is filled with alcohol. Inside the alcohol is a little glass rod. As the temperature drops and the alcohol gets smaller it drags the indicator back with it and so shows the lowest temperature reached (in the thermometer drawn here 74°). In actual practice the two thermometers are mounted with the bulb of one to the left and of the other to the right. A single shake then sends both indicators back to the starting position, in contact with the mercury column in the one case, and inside the end of the alcohol column in the other.

temperature. The table given below is an actual series of observations for a station at Calcutta for the month of July, 1926. It illustrates the method of obtaining (*a*) the mean maximum, (*b*) the mean minimum, (*c*) the mean temperature of the month.

Day.	Max. Temperature.	Min. Temperature.	Average.
1st	95	81	88·0
2nd	95	82	88·5
3rd	95	82	88·5
4th	97	81	89·0
5th	97	81	89·0
6th	88	78	83·0
7th	83	77	80·0
8th	89	80	84·5
9th	89	81	85·0
10th	91	80	85·5
11th	90	79	84·5
12th	88	79	83·5
13th	89	80	84·5
14th	89	79	84·0
15th	86	79	82·5
16th	89	81	85·0
17th	92	80	86·0
18th	85	78	81·5
19th	87	77	82·0
20th	87	77	82·0
21st	90	75	82·5
22nd	85	78	81·5
23rd	84	78	81·0
24th	87	79	83·0
25th	89	78	83·5
26th	87	78	82·5
27th	88	79	83·5
28th	88	81	84·5
29th	88	78	83·0
30th	86	77	81·5
31st	81	76	78·5
	31)2754	31)2449	31)2601·5
	88·8 (*a*)	79·0 (*b*)	83·9 (*c*)

Average Temperatures.—Some years are hotter or colder than others and, for accurate averages, thirty-five years is recognized as the standard period over which records should be kept. This ideal is far from being obtained in the case of many stations where records are only available over a few years. In the comparative study of climate the most important figures are the *monthly* averages, especially for the hottest and coldest months of the year. The table in the last paragraph shows the method of obtaining the average temperature of Calcutta for the month of July, 1926. Such records over a series of years enable the true average for that month to be calculated thus :

Station.	Year.	Average January Temperature.
"A"	1915	46·2°
"	1916	44·8°
"	1917	45·1°
"	1918	45·7°
"	1919	46·8°
"	1920	46·4°
"	1921	44·8°
		7)319·8
		45·6° = Average Jan. temperature.

The difference between the average temperatures of the hottest and coldest months in the year—usually January and July—is the *annual range.* Stations having an "insular" or "oceanic" type of climate have a small range—maritime stations in equatorial regions may have a range of only two or three degrees ; stations far from the moderating influence of sea have a "continental" type of climate and the range may be as much as 100°. In this connection it may be observed that it is characteristic of land that it gets hot quickly (as during the day when the sun is shining) but loses its heat quickly (as during the night). Figs. 20 and 21 show how sea breezes by day and land breezes by night result from this. Water, on the other hand, takes much longer to get hot but longer to get

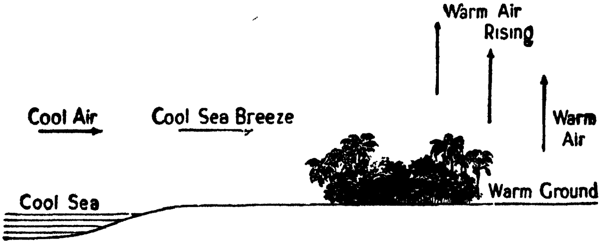

Warm Air
Rising
Cool Air
Cool Sea Breeze
Warm Air
Warm Ground
Cool Sea

FIG. 20.—Diagram showing the cause of a cool sea breeze by day.

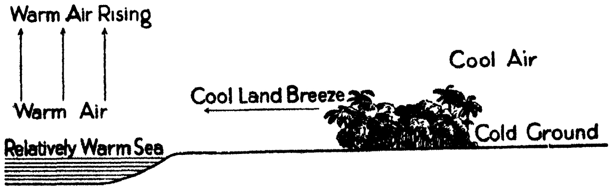
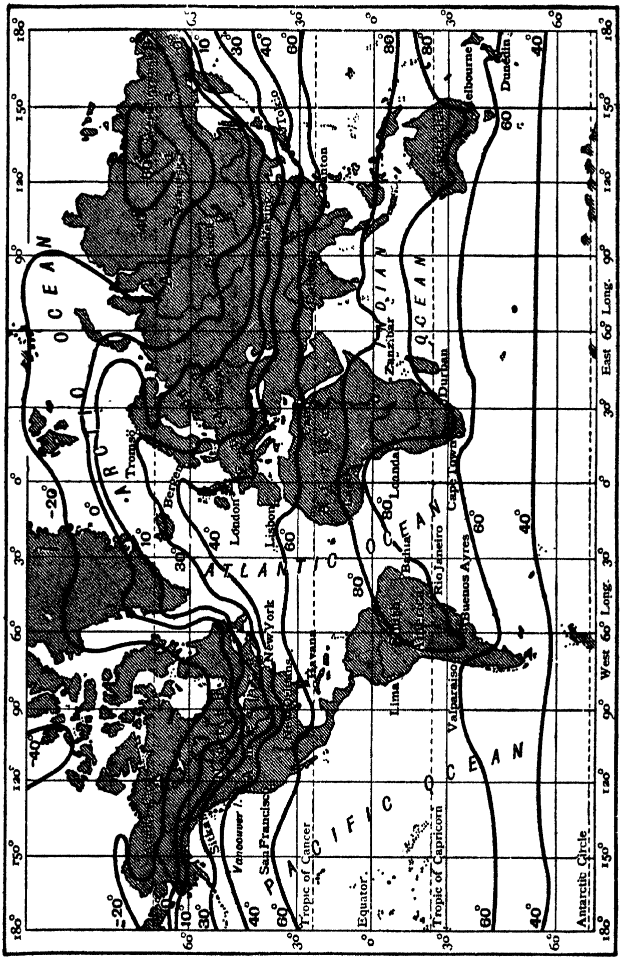

Warm Air Rising
Cool Air
Cool Land Breeze
Warm Air
Cold Ground
Relatively Warm Sea

FIG. 21.—Diagram showing the cause of a land breeze by night.

cold. The air over great bodies of water has a much smaller range of temperature than over the land.

The extreme temperatures ever recorded at a station are known technically as the " absolute maximum " and " absolute minimum."



ARCTIC OCEAN
ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
Tromsö
Bergen
London
Lisbon
New York
Havana
San Francisco
Vancouver I.
Sitka
Tokio
Peking
Zanzibar
Durban
Cape Town
Loanda
Bahia
Rio Janeiro
Buenos Ayres
Valparaiso
Lima
Melbourne
Dunedin
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
West 60° Long.
East 60° Long.
Long.
0°
30°
60°
90°
120°
150°
180°
-40°
-20°
0°
10°
30°
40°
60°
80°

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Emery Walker sc.

FIG. 22.—January isotherms of the world.

[*From Longmans' Geographical Series. Book III.*

Altitude and Temperature.—Roughly for every 300 feet of ascension the temperature drops 1° F. Thus a place 3,000 feet above sea-level would be ten degrees warmer if it were at sea-level. For certain purposes recorded temperatures are reduced to sea-level equivalents in this way. Thus *isotherms* are simply lines on a map drawn through all places having the same sea-level temperature. In recent years climatologists have paid attention to actual temperatures rather than to sea-level equivalents.

World Isotherms.—Figs. 22 and 23 show the January and July isotherms for the world. These show at once that the temperatures do not decrease gradually and steadily from the equator to the poles. In the Northern Hemisphere the presence of large land masses complicates matters far more than in the Southern Hemisphere.

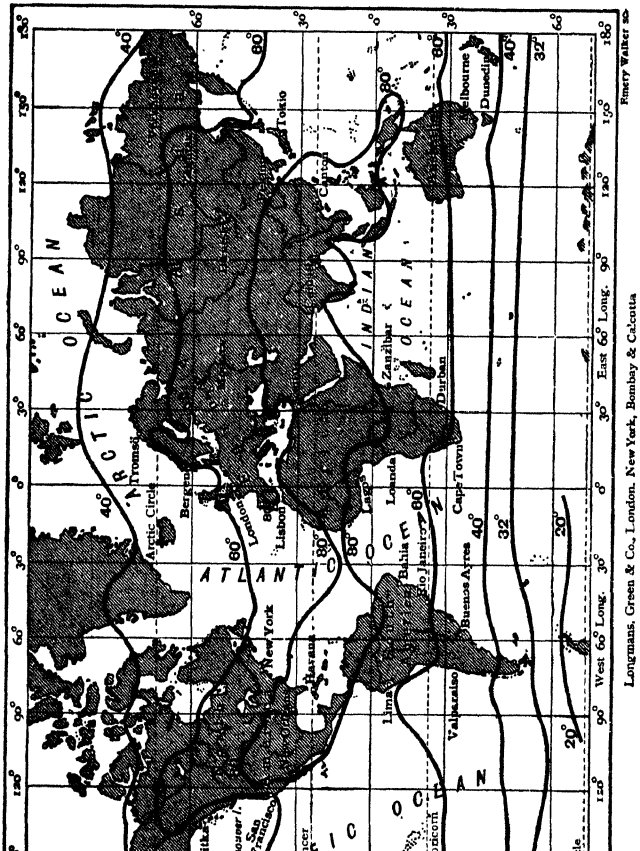
ARCTIC OCEAN
ATLANTIC OCEAN
INDIAN OCEAN
PACIFIC OCEAN
Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle
Tromsö
Bergen
London
Lisbon
New York
Havana
Lagos
Loanda
Bahia
Rio Janeiro
Buenos Ayres
Valparaiso
Lima
Cape Town
Durban
Zanzibar
Canton
Tokio
Melbourne
Dunedin
Sitka
Vancouver I.
San Francisco
40°
60°
80°
32°
20°
180°
150°
120°
90°
60°
30°
0°
West 60° Long.
East 60° Long.
Emery Walker sc

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FIG. 23.—July isotherms of the world.

[*From Longmans' Geographical Series, Book III.*

Rainfall.—In order to have rain two important conditions must be satisfied. First, there must be moisture-laden air; secondly, there must be some means whereby the air is cooled and condensation takes place. The moisture-laden air may be cooled in two principal ways:

(*a*) By rising upwards into the colder, upper regions of the atmosphere.

(*b*) By being blown as wind to colder regions.

Rains are also classified into three important types:

(1) *Convectional Rains.*—In equatorial and other hot regions evaporation is very great. The hot, moist air, being light, rises, expands, cools, and rain falls. The rain may fall in exactly the same area from which evaporation took place. Most of the heavy rainfall in the Equatorial Belt probably thus originates.

(2) *Relief Rains.*—Moisture-laden air, blowing towards hilly country, is forced to rise, and in so doing is cooled. The rains originating in this way are relief rains.

(3) *Cyclonic Rains.*—The ascending air currents associated with low-pressure systems give rise to rains which are especially important in temperate latitudes and in rain-shadow areas.

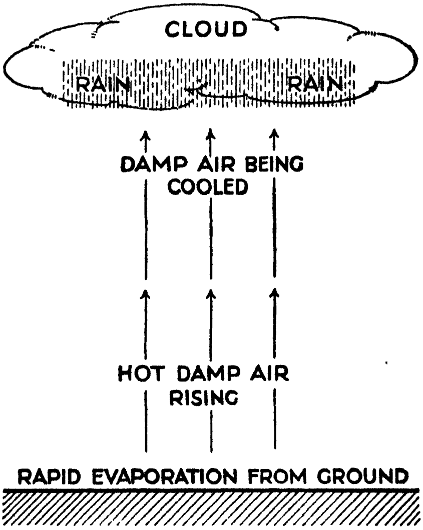

Fig. 24.—Convectional rains.[1]

It will be seen that the two principal factors controlling the rainfall of a locality are the direction of the prevalent winds and the configuration of the land.

The expression "rain-shadow area" is used above. When a moisture-laden wind is forced to rise to pass over a mountain range it is cooled and loses some of its moisture. When the wind has finally passed over the range it has not only lost much of its moisture

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[1] Many meteorologists believe that very little rain would fall under the conditions shown in this diagram unless there is also cyclonic disturbance of the air.

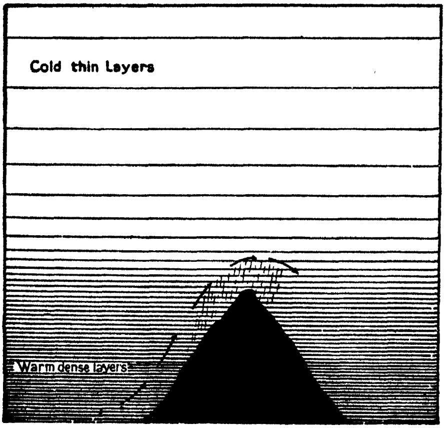
Cold thin Layers
Warm dense layers

FIG. 25.—Relief rains.

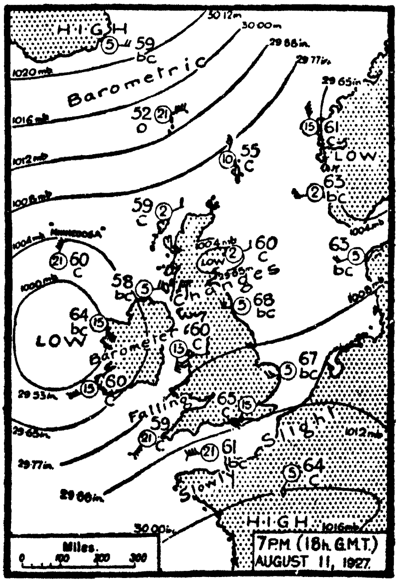
HIGH
Barometric
Changes
Barometer
Falling
Slightly
Slowly
LOW
LOW
LOW
HIGH
1020 mb
1016 mb
1012 mb
1008 mb
1004 mb
1000 mb
30·12 in.
30·00 in.
29·88 in.
29·77 in.
29·65 in.
29·53 in.
"MINNEDOSA"
Miles.
0 100 200 300
7 P.M. (18h. G.M.T.)
AUGUST 11, 1927.

FIG. 26.—Weather chart showing a typical cyclonic system moving slowly eastwards across the British Isles.

Figures in circles show strength of wind in miles per hour; other figures are temperature(°F.)

(*Reproduced from "The Times," London, by permission of the Proprietors.*)

but it is warmed by compression in its descent or passes into the lower, warmer layers of the atmosphere and does not give up any more moisture. The *windward* side of the range is thus wet, the *leeward* side is said to lie in the "rain shadow" of the mountains and is dry. The north-east coast of England lies in the rain shadow of the Pennine Chain; the Canterbury Plains of New Zealand in the rain shadow of the Southern Alps. Many other examples might be given.

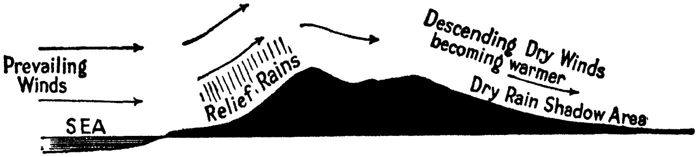

FIG. 27.—Section showing a rain-shadow area.

The warm descending winds are of the type known as "Föhn" or "Chinook" winds.

Recording Rainfall.—Rainfall is measured by means of a rain-gauge. All the rain which falls over a certain small area passes into a funnel and is collected in a jar from which it cannot evaporate and where it can be measured. When we say that the rainfall for one day has been 0·5 inches we mean that if all the rain which fell that day had remained where it fell, it would have formed a layer 0·5 inches deep. The following record shows the readings of rain-gauges at a number of Indian cities during the month of July, 1926:

Day.	Calcutta.	Delhi.	Madras.	Bombay.
1st	—	—	—	1·17
2nd	—	—	—	0·39
3rd	—	—	0·05	0·83
4th	—	—	0·96	2·31
5th	0·03	—	—	4·00
6th	1·87	—	—	1·02
7th	2·48	—	0·24	1·64
8th	0·06	—	—	3·41
9th	—	—	—	5·31
10th	0·01	—	0·46	—
11th	0·05	—	0·22	0·11
12th	0·23	1·16	—	2·02
13th	0·84	0·15	0·02	0·32
14th	0·14	2·90	—	0·37
15th	0·14	0·44	—	0·38
16th	0·01	0·01	—	0·95
17th	0·83	—	—	0·89
18th	0·85	—	—	0·20
19th	0·88	0·45	—	0·15
20th	0·25	0·09	—	0·01
21st	4·01	0·28	—	0·26

Day.	Calcutta.	Delhi.	Madras.	Bombay.
22nd	6·61	—	—	0·02
23rd	1·21	—	0·07	0·12
24th	0·69	—	0·15	0·63
25th	0·63	0·98	0·33	0·57
26th	0·49	0·15	—	2·24
27th	0·16	2·35	0·20	0·22
28th	0·07	1·60	—	0·26
29th	0·48	0·06	—	0·83
30th	1·12	0·26	—	0·17
31st	1·23	0·50	—	0·08
Total	25·37	11·38	2·70	30·88

Notice that the *total* for the month is the figure of importance (compare temperature, which is somewhat different). The *monthly averages* are calculated by averaging the records for a number of years thus:

Place A.	Jan.	Feb.	Mar.	April	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Year.
1920	3·7	2·5	1·9	0·7	0·3	0	0·1	0	0·7	3·1	2·5	2·4	
1921	4·2	1·8	1·9	1·1	0·2	0·2	0	0	0·1	2·1	2·9	2·9	
1922	2·8	1·7	1·8	0·6	0·3	0·1	0	0·1	0	1·3	2·0	3·4	
1923	3·5	2·3	2·0	1·2	0·8	0·3	0·3	0	0·3	0·9	1·8	3·0	
1924	3·3	3·3	1·1	0·5	0·6	0·4	0·1	0·1	0	0·8	1·7	4·6	
1925	5·0	4·2	1·3	1·1	0·4	0·2	0	0·2	0·5	1·6	1·9	4·5	
1926	4·1	3·0	2·1	0·7	0·1	0	0·2	0	0·3	1·9	2·7	5·5	
1927	2·9	3·1	1·2	0·8	0·3	0·1	0·1	0·1	0·8	1·3	3·1	5·2	
Average													

Of great importance is the *total* or average rainfall for the year, obtained by *adding together* the monthly averages.

Rainfall Régimes.—In studying rainfall, it is important to note two things:

(*a*) The total rainfall. Rainfall includes other forms of precipitation, *e.g.* snow, one foot of snow being equivalent to one inch of rain. Owing to the greater heat and evaporation a poor rainfall in the tropics might be quite adequate in colder lands. As a *very rough* guide it is useful to remember that in the tropics:

(1) Above 80 inches is a heavy rainfall. If much more it may be excessive.
(2) 40 to 80 inches is a moderate rainfall.
(3) 15 to 40 inches is a light or poor rainfall
(4) Below 15 inches is a very poor rainfall.

In temperate regions, on the other hand:

(1) Above 40 inches is a heavy rainfall.
(2) 15 to 40 inches is a moderate rainfall.
(3) 5 to 15 inches is a light or poor rainfall.
(4) Below 5 inches is a very poor rainfall.

Regions with less than 15 inches per annum in the tropics or less than 5 inches in temperate regions are usually deserts.

(*b*) The seasonal distribution or "régime" of the rainfall. The importance of this will be seen when the main climatic types are considered.

On maps, lines of equal rainfall (isohyets or isohyetal lines) may be drawn for the year, for individual months, or for stated periods.

The Pressure Belts of the World.—Fig. 28 shows the hypothetical distribution of pressure on the globe which might be expected to exist if the earth's surface were regular—consisting entirely of land or entirely of water. This "planetary" arrangement of pressure belts gives rise to what are known as the "planetary" or regular wind systems. We shall not attempt here to explain fully the reason for this distribution of pressure; recent investigations of the currents in the upper atmosphere have shown that the movements are not as simple as was once believed. Excessive heat and centrifugal force combine to cause the equatorial low-pressure belt. Polewards there are two high-pressure belts, north and south, just outside the tropics. The extreme cold at the poles gives rise to two high-pressure areas, whilst intervening belts of low pressure occur in the high latitudes of cold temperate regions.

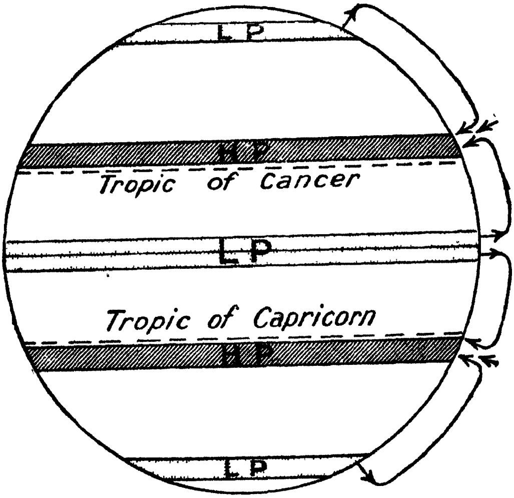

Fig. 28.—Diagram showing the pressure belts of the globe.

Air normally moves from regions of high pressure to regions of low, but the N.-S. direction of the winds which would result from the great pressure belts of the globe is affected by the rotation of the earth. As a result the planetary winds, or regular winds, are arranged as shown in Fig. 29.

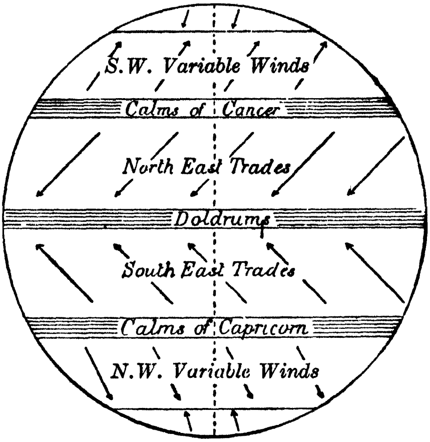
S.W. Variable Winds
Calms of Cancer
North East Trades
Doldrums
South East Trades
Calms of Capricorn
N.W. Variable Winds

FIG. 29.—The regular wind systems of the world.

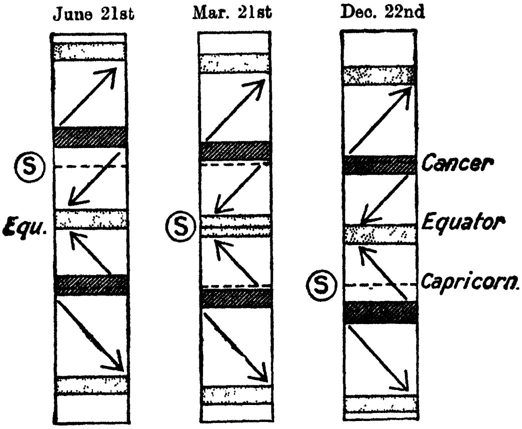
June 21st
Mar. 21st
Dec. 22nd
S
Equ.
S
S
Cancer
Equator
Capricorn.

FIG. 30.—Diagram showing the swing of the wind systems.
The pressure belts are indicated as in Figs. 28, 31, and 32. S represents the position of the "vertical" sun, i.e. the belt where the sun is shining vertically.

It has been noted that the equatorial low-pressure belt is due, in the main, to great heat. But the earth's thermal equator moves northwards or southwards according to the seasons. In the northern summer, when the sun is shining vertically over the Tropic of Cancer, the thermal equator lies to the north of the equator and the whole system of pressure belts and planetary winds moves northwards. In the northern winter the position is reversed. This seasonal phenomenon is known as the "swing of the wind systems." The total swing is small—from 6 to 8 or 10 degrees.

The shape and disposition of the land masses profoundly affect the planetary wind systems. The great land masses, in particular North America and Eurasia, become very hot in the northern summer and low-pressure centres are formed over them towards which the winds are drawn; in the northern winter they become very cold and form great high-pressure systems. Fig. 31 shows the way in which the planetary winds are affected. In the Southern Hemisphere, where the land masses are much smaller, the Trade and N.W. Variable Winds are much more regular.

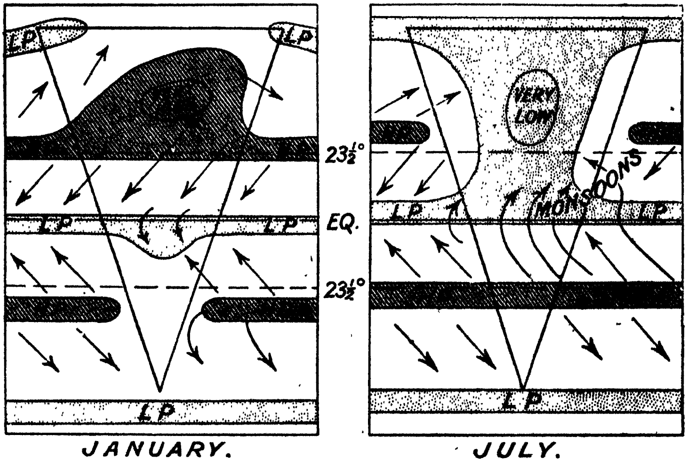

FIG. 31.—Diagram showing the effect of the land masses (represented by the triangles) on the pressure belts of the world.

Compare this very carefully with Fig. 28. (*After Kendrew.*)

It is essential that the arrangement of the chief winds—the Trades and "Westerlies"[1]—be clearly understood.

Cyclones and Anti-cyclones.—The planetary winds do not blow with absolutely steady regularity. In the Northern Hemisphere, in particular, the South-West Variable Winds represent the general drift of the air currents, but the current of air, instead of moving steadily from south-west to north-east, moves rather as a series of eddies and whirls, comparable with the eddies and whirls in a stream of water. These little air swirls are caused by differences in pressure and are called cyclones (“ lows ” or “ depressions ”) and anti-cyclones (“ highs ”). A cyclone has a low-pressure centre and inblowing winds; an anti-cyclone has a high-pressure centre with outblowing winds. The associated winds have at the same time a whirling motion around the centre—in a counter-clockwise direction round a cyclone, in a clockwise direction around an anti-

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[1] Or "Variables," formerly called "Anti-Trade" Winds.

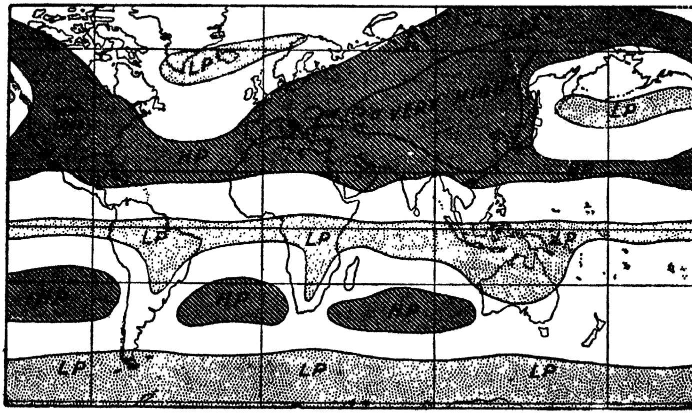
LP
LP
LP
LP
LP
HP
HP
HP
LP
LP
LP

Fig. 32.—Map showing the pressure belts of the world in January. Compare this with the diagrammatic scheme shown in Fig. 31.

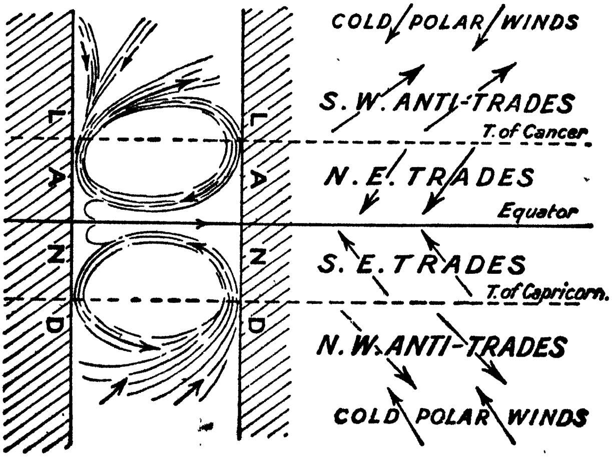
COLD POLAR WINDS
S.W. ANTI-TRADES
T. of Cancer
N.E. TRADES
Equator
S.E. TRADES
T. of Capricorn.
N.W. ANTI-TRADES
COLD POLAR WINDS
L
A
N
D
L
A
N
D

Fig. 33.—The general arrangement of currents and winds.

cyclone in the Northern Hemisphere. These directions are reversed in the Southern Hemisphere.

In many temperate lands cyclones are associated with wet,

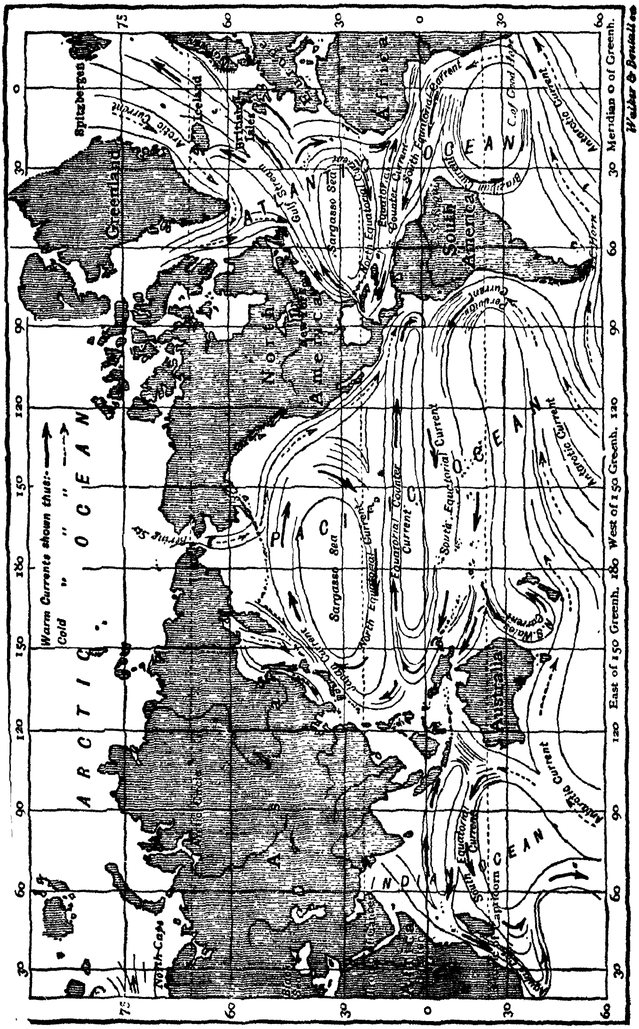
Spitzbergen
Iceland
Greenland
British Isles
Arctic Current
Gulf Stream
Sargasso Sea
North Equatorial Current
Equatorial Counter Current
South Equatorial Current
Brazil Current
Benguela Current
C. of Good Hope
Antarctic Current
ATLANTIC OCEAN
AFRICA
SOUTH AMERICA
C. Horn
Peruvian Current
NORTH AMERICA
PACIFIC OCEAN
Sargasso Sea
Japan Current
Australia
N.S. Wales Current
INDIAN OCEAN
Capricorn
ASIA
Arctic Circle
North Cape
ARCTIC OCEAN
Warm Currents shown thus:
Cold " " "
30 Meridian 0 of Greenh.
East of 150 Greenh.
West of 150 Greenh.
75
60
30
0
90
120
150
180

FIG. 34.—Currents of the oceans.

[From Longmans' Geographical Series, Book V. Walker & Boutall

cold, and stormy weather; anti-cyclones with dry, fine weather (but sometimes foggy in winter).

Tornadoes, hurricanes, or typhoons are local but very intense depressions, characteristic of tropical or sub-tropical rather than temperate lands.

Ocean Currents.—The currents of the ocean have an important effect on the climates of countries whose shores they lave. Cold currents—that is, those currents flowing from a colder region to a warmer and therefore cold in a relative sense rather than an absolute—have a distinct chilling effect. The cold current which, especially in winter, flows along the coast of North America past New York is in some measure responsible for the severe winters of that coast. On the other hand, the beneficial influence of the North Atlantic Drift (often mistakenly referred to as the Gulf Stream, of which it is a continuation) on the climate of North-Western Europe is well known. The ocean currents are, in the main, the result of the regular wind systems of the globe, as shown in Fig. 32. The existing currents should be carefully studied in Fig. 33.

EXERCISES

1. Calculate the average rainfall for each month of the Place " A " in the incomplete table given above ; also the total rainfall for each of the years 1920–1927.
   (*a*) Draw an average monthly rainfall graph.
   (*b*) Make a note of important deviations from the normal.
   (*c*) Express the rainfall of 1927 in percentage deviations, month by month, from the normal.

2. By studying Fig. 33 make a list of (*a*) those countries under the influence of warm currents, (*b*) those countries under the influence of cold currents.

EXAMINATION QUESTIONS

1. What conditions lead to great variations in temperature (*a*) annual, and (*b*) diurnal ? (*Univ. Oxford Cert.*, 1926.)

2. What do you mean by the climate of a particular region ? What material may be used to determine it ? (*Univ. Oxford Cert.*, 1927.)

3. Explain the factors favouring the formation of rain ; suggest a simple classification of rainfall based on your observations, indicating regions where such types as you suggest prevail. (*Univ. Sheffield Inter. Hons.*, 1925.)

4. Describe the atmospheric conditions present in a cyclone of temperate latitudes and compare them with a tropical cyclone. (*Univ. Sheffield Inter.*, 1926.)

5. What is regarded as the main cause of ocean-currents ? Illustrate by an account of the currents *either* of the Atlantic *or* of the Pacific Ocean. (*Univ. Bristol Inter.*, 1927.)

6. Discuss the main factors which determine the climate of an area, distinguishing between the cosmic and purely geographical factors. Illustrate from definite examples. (*Univ. Bristol Inter.*, 1927.)

7. Describe in detail the various factors determining the temperature of any point on the earth's surface. (*Univ. British Columbia Sessional*, 1927.)

8. Describe the planetary winds. What other types of wind occur on the earth's surface and how do they arise ? (*Univ. British Columbia Sessional*, 1927.)

9. Account for the general distribution of temperature in the Southern Hemisphere as shown by a mean annual temperature chart. (*Univ. Sheffield Inter.*, 1925.)

10. Describe with the aid of diagrams the wind systems of the world, giving their causes and effects.

11. What is an isotherm? Explain how an annual isotherm chart is constructed, stating what observations have to be made. On such a chart of the world it is noticed that the isotherms run approximately in the direction of the parallels of latitude. Explain this fact, and state (with reasons) any marked exception to it that you know of.

12. How is rainfall measured, and how is a rainfall map constructed? Illustrate your answer by drawing and explaining a rainfall sketch-map of any actual country. (*Univ. Rangoon Inter*, 1925)

13. What is meant by monsoons and how are they caused? Discuss the above with special reference to India. Define a cyclone.

14. What are the different types of currents and how do they originate? Illustrate the main warm currents on a sketch map of the world. How do they influence the climate of the neighbouring countries in each case?

15. How is temperature measured and recorded? What is meant by an isotherm map?

16. Give a brief account of the main wind systems of the earth, noting the causes of the winds and of their variation from one part of the year to another. (*Univ. Rangoon Inter*, 1926.)

17 If, on a map showing mean annual temperature, two towns lie on the same isotherm, how far would one be justified in concluding that they had the same temperature conditions? (*Univ London Inter. B. Com*, 1920)

18 You require information as to the climate of a certain town If *only* maps are available, what kinds of maps would you use, what information would you look for, and what reservations would you make in adopting this information? (*Univ. London Inter. B. Com.*, 1921.)

19. What are the chief factors that cause differences in (*a*) mean annual temperatures, and (*b*) annual ranges of temperature, between one place and another? (*Univ. London Higher Schools*, 1932.)

20. Examine by means of actual examples the influence of ocean currents upon the climates of the areas near whose shores they pass. (*Univ. London Higher Schools B and D*, 1932.)

APPENDIX

THE MAJOR CLIMATIC REGIONS OF THE WORLD

THE recognition of a number of climatic types and the conception of the world divided into climatic regions is due, in the main, to the late Professor A. J. Herbertson of Oxford. It is found that the same type of climate occurs in regions near the equator whether they be in America, Africa, or Asia. Again, another distinctive type is found roughly around latitude 35° on the west side of Europe, North America, South America, Africa, and Australia. What is more important, the same type of vegetation reappears in each region under the sway of a particular climatic type; the activities of man, especially in relation to agriculture, tend to be the same in each area of the world where a particular type of climate is found. The world can, therefore, be divided into "*major natural regions*" on the basis of climate.

About a dozen well-marked climatic types can be distinguished, and it is desirable to consider each in some detail. Naturally, the divisions between climatic provinces are not, as a rule, sharply marked lines; one type tends to fade gradually into another and often considerable tracts may best be regarded as transitional areas. Further, there is obviously considerable variation from one part of a climatic region to another part; local variations due especially to topographical features, notably elevation, are found in all regions.

The most distinctive climatic types may be grouped as follows:

1. Equatorial type
2. Tropical type
3. Monsoon type
4. Hot Desert type

Climates of Low Latitudes or the Tropical Zone (Hot Lands).

5. Temperate Desert type
6. Mediterranean type
7. Warm Temperate East Coast type
8. Cool Temperate Oceanic type
9. Temperate Continental type
10. "St. Lawrence" type
11. Cold Temperate type

Climates of Middle Latitudes or the Temperate[1] Zone.

12. Arctic or Cold Desert type

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[1] "Temperate" is here used as meaning "in the Temperate Zone," *i.e.* in Mid-Latitudes. Thus many of the temperate climates are actually climates of great extremes.

So marked is the influence of climate on vegetation that the climatic type is often named after the prevailing vegetation. Thus the Temperate Continental Climate may be called the Temperate Grassland or Prairie type; the Cold Temperate Climate the Coniferous Forest type, and so on.

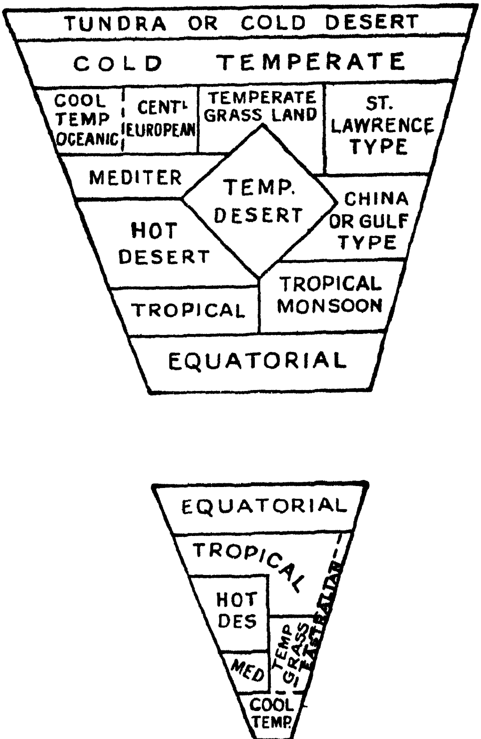
TUNDRA OR COLD DESERT
COLD TEMPERATE
COOL TEMP OCEANIC
CENTL EUROPEAN
TEMPERATE GRASS LAND
ST. LAWRENCE TYPE
MEDITER
TEMP. DESERT
CHINA OR GULF TYPE
HOT DESERT
TROPICAL
TROPICAL MONSOON
EQUATORIAL
EQUATORIAL
TROPICAL
HOT DES
MED
TEMP GRASS
EASTRALIAN
COOL TEMP.

FIG. 35.—Diagram showing the mutual relationships of the main climatic types. Notice the contrast between the broad land masses of the Northern Hemisphere and the narrower lands of the Southern Hemisphere.

In addition to the twelve main climates listed above another four or five may be distinguished; but they owe their distinctive characters mainly to altitude and may be treated as subdivisions.

THE EQUATORIAL CLIMATE

The Equatorial Climate, as its name implies, occurs as a belt on either side of the equator, normally extending roughly between

5° North and 5° South. Its most typical development is in the basin of the Amazon, hence the name, "Amazon Type." The characteristic vegetation is tall, evergreen forest, hence the descriptive name, "Climate of the Hot, Wet Forests or Selvas."

Temperature.—The temperature is high all the year round, and is characterized by its very small variation. In typical localities the average for the year is between 78° and 80°; the range between the hottest and coldest months is typically less than 5°. Similarly, the differences between day and night temperatures are small and may be taken as typically less than 20°. The equatorial regions are often popularly regarded as the hottest in the world. The average temperature, it is true, is uniformly high and the constantly damp, steamy atmosphere may be enervating, but the equatorial climate is far from being the most trying in the world. The absence of really high temperatures—the thermometer very rarely rises above 100° F.—and the pleasantly cool rains which accompany the afternoon thunderstorms make the climate quite pleasant. This is particularly the case in maritime situations such as the island of Singapore where land and sea breezes impart a welcome movement to the air. The climate is found at its worst in the interior of the great equatorial forests where the air is absolutely still.

The effect of elevation is to lower the average temperature and, sometimes, to result in a slightly greater range. In elevated plateau regions in the equatorial belt, the temperature is so much lower that a separate climatic type is often distinguished. This is known as the "Ecuador Type," being found typically on the high plateau of Ecuador at an elevation of between 8,000 and 10,000 feet. At the town of Quito, almost on the equator, the average temperature is only 55° and the annual range less than one degree. The Englishman, bearing in mind the balmy days of the English spring, has named the Ecuador plateau the "Land of Eternal Spring."

The temperature and rainfall figures[1] given below are of a number of typical stations in the Equatorial Belt. *Manaos* (lat. 3° 15′ S.) is in the heart of the Amazon Forests, nearly a thousand miles from the sea but only 130 feet above sea-level. *Para* (lat. 1° 27′ S.), near the Brazilian coast, enjoys the advantages of land and sea breezes. The difference between day and night temperatures is between 10 and 20 degrees. *Libreville* (lat. 0° 23′ N.) is typical of the coast of equatorial Africa. *New Antwerp* (lat. 2° 0′ N.) is 1,200 feet above sea-level in the heart of the Congo Basin. *Lagos* (lat. 6° 28′ N.) has been chosen as an example of a place towards the fringes of the Equatorial Belt. *Batavia* (lat. 6° 11′ S.) is similarly on the fringes of the belt but to the south of the equator. *Ocean Island* (lat. 0° 52′ S.), in the heart of the Pacific, shows the extremely small range of a truly maritime climate in equatorial regions. The daily range is 13° all the year round.

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[1] Temperature and rainfall figures in this chapter are taken from W. G. Kendrew, "The Climates of the Continents"; L. B. Cundall and C. B. Thurston, "Climatic Data" (*Geography*, Vols. XIII and XIV); the Memoirs of the Indian Meteorological Survey, and Monthly Rainfall of India

Quito (lat. 0° 14′ S.), at a height of 9,350 feet, is typical of the "Ecuador Type" of climate.

Rainfall.—In equatorial regions the rain falls at all seasons of the year and there is no "dry season," except in a relative sense. Typically the equatorial lands may be considered as lying in the Belt of Calms or Doldrums and the rains are mainly, sometimes entirely, convectional rains. During the early part of the day bright sunshine induces rapid evaporation and an upward current in the atmosphere. The ascending, moisture-laden air becomes cooled and clouds form. The formation of clouds in the afternoon and the subsequent precipitation is frequently accompanied by thunder, and in many parts of the equatorial regions clear, morning sunshine and afternoon thunderstorms are the usual rule. The rain falls in torrential downpours, usually of short duration. This daily programme is not evident from the average statistics which show an average of cloud in typical equatorial stations of between 3 and 7 throughout the year. The relative humidity in regions of equatorial climate is uniformly high, being on an average over 80 per cent. throughout the year. Although rain falls throughout the year in equatorial regions, it is usually found that there are either one or two periods of maximum rainfall. Stations near the equator usually have two periods; stations on the northern or southern fringes of the belt usually one. In most cases the rainfall maximum or maxima occur shortly after the period when the sun is vertical. The rainfall is thus strongly affected by the movement of the planetary winds, and it is only in isolated stations very close to the equator that the rainfall is entirely convectional. The further one goes away from the equator, the greater the proportion of rainfall which tends to be due to other causes. The great Amazon Basin, for example, forms a huge low-pressure area into which the Trade Winds are drawn; the coast of the Gulf of Guinea (see figures for Lagos given below) owes its rainfall to the formation of a low-pressure strip into which the South-East Trade Winds are drawn from across the equator. These points are emphasized when one studies the prevalent wind direction at equatorial stations. In island stations, such as Ocean Island, winds are light and variable; at slight distances north of the equator the wind direction tends to be strongly influenced by the normal wind further north; short distances south of the equator by the normal winds further south. Lagos has south-west winds as in the Sudan to the north; Singapore shares in the changes of the Indian Monsoon.

The equatorial regions are essentially regions of heavy rainfall.

The total for the year ranges in typical stations from 70 or 80 inches

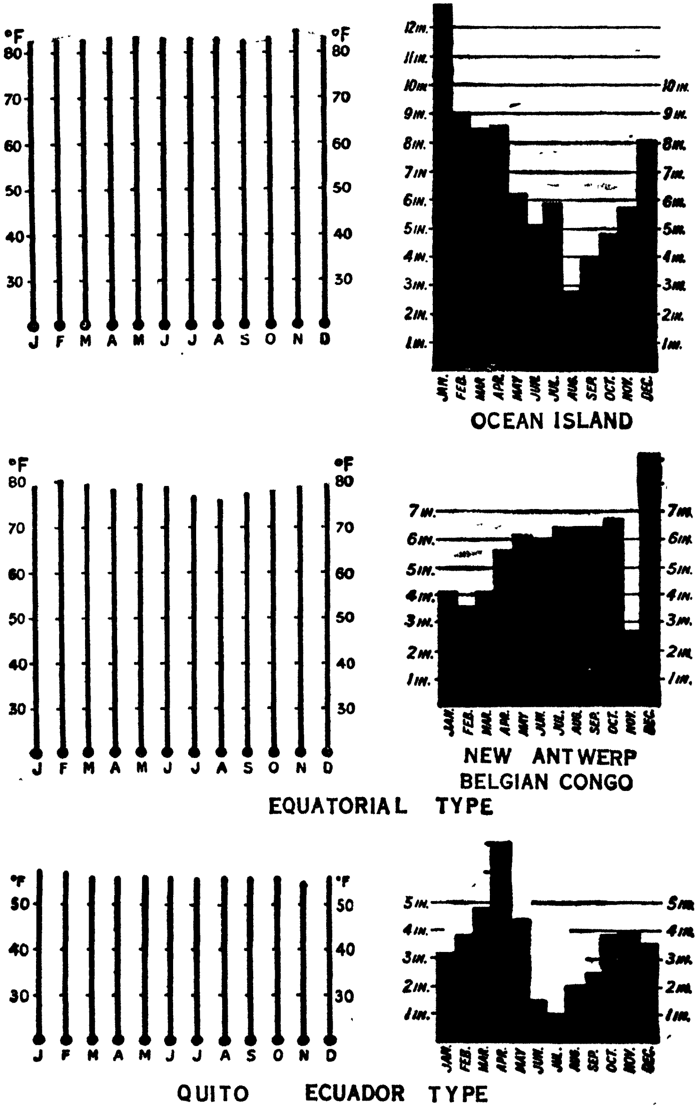

FIG. 36.—The Equatorial Climate—Temperature and Rainfall Graphs.

upwards. Areas cut off from the influence of the sea and its ready supply of moisture—as in the interior of the Congo Basin—may have rather less. The Ecuador type, at high altitudes where evaporation is very much less, has a smaller rainfall.

EQUATORIAL CLIMATE—TEMPERATURE[1]

Station	Height above Sea.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Manaos .	131	78	78	*78*	78	78	79	79	79	80	80	**81**	80	2·7°
Para . .	42	78	*77*	77	78	78	78	78	78	79	79	**80**	79	2·7°
Libreville .	115	80	80	**81**	**81**	80	77	*75*	76	77	78	78	79	6°
New Antwerp	1230	79	**80**	79	78	79	78	77	*76*	77	77	78	78	4°
Lagos . .	25	80	81	**82**	81	80	77	76	*76*	77	78	80	80	6°
Batavia . .	66	78	*78*	79	79	80	79	79	79	80	**80**	79	78	2°
Ocean Island	84	82	82	82	82	82	82	82	82	82	82	**83**	82	1°
Ecuador Type														
Quito . .	9350	55	55	55	55	**55**	55	55	**55**	**55**	**55**	*54*	**55**	0·7°

EQUATORIAL CLIMATE—RAINFALL IN INCHES

Station	Jan.	Feb	March	April	May	June	July	Aug.	Sept.	Oct	Nov.	Dec.	Year
Manaos . .	0·8	9·6	11·8	13·0	7·5	5·1	3·0	1·8	1·5	3·9	6·4	10·3	83·7
Para . .	10·3	12·6	13·3	13·2	9·3	5·7	4·9	4·3	3·2	2·5	2·3	5·1	86·7
Libreville .	8·9	8·5	13·3	12·8	7·8	0·3	0·1	0·7	3·9	14·0	14·8	9·7	94·8
New Antwerp	4·1	3·5	4·1	5·6	6·2	6·1	6·3	6·3	6·3	6·6	2·6	9·3	66·9
Lagos . .	1·1	2·0	3·7	6·3	10·1	19·2	10·2	2·4	5·3	8·6	2·4	0·9	72·2
Batavia .	13·0	13·6	7·8	4·8	3·7	3·6	2·6	1·3	2·6	4·1	5·0	8·7	70·9
Ocean Island	12·9	9·0	8·4	8·5	6·1	5·1	5·7	2·7	3·9	4·8	5·7	8·0	80·8
Ecuador Type													
Quito .	3·2	3·9	4·8	7·0	4·6	1·5	1·1	2·2	2·6	3·9	4·0	3·6	42·3

Vegetation.—The ever-wet, ever-hot climate of equatorial regions produces a very rank, luxuriant vegetation. There is fierce competition, not for moisture, but for light and air. The Amazon Basin is the most characteristic region and is clothed with an evergreen forest of giant trees. These hot, wet forests or selvas contain a great variety of trees; it is rarely that more than two or three of the same species are found in the space of a single acre. They nearly all agree in having tall, unbranched boles, with a crown of leaves at the top. The crowns form a close, interlacing mass often so thick that sunlight never reaches the ground, and the interior of the forest is gloomy and lifeless in the extreme. This gloomy, vault-like type of equatorial forest is almost restricted to South America; the forests of equatorial Africa and Asia are more open. Although nearly all the trees have short "resting periods" and shed their leaves, the resting periods of the different species come at different seasons and the forest is never bare of leaves. The trees are nearly all very hard-wooded species; so rare is soft wood in the forest that Manaos imports its building timber from the temperate regions of North America The struggle for light and air, which are only found above the tree-tops, has resulted in the existence of large numbers of woody climbers or lianes. The trees by which these climb may afterwards die and rot away, leaving the great coils of the climber pendulous from the height above, and forming tangled, impenetrable masses on the ground. Epiphytes are also abundant; ferns and flowering plants finding a foothold on the higher branches of the trees and thus reaching the light. Most orchids of equatorial lands occur thus. In the denser forests of South America the ground is almost devoid of living plants: it is littered with a mass of decaying vegetation.[1] This is more particularly the case where the Amazon and its tributaries overflow their banks and cause wide morasses. In the more open forests of Africa and Asia there is a luxuriant ground vegetation of broad-leaved herbs.

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[1] In all the tables showing temperature in this chapter, figures for the *coldest* month are in italics, figures for the *hottest* month in **heavy type**.

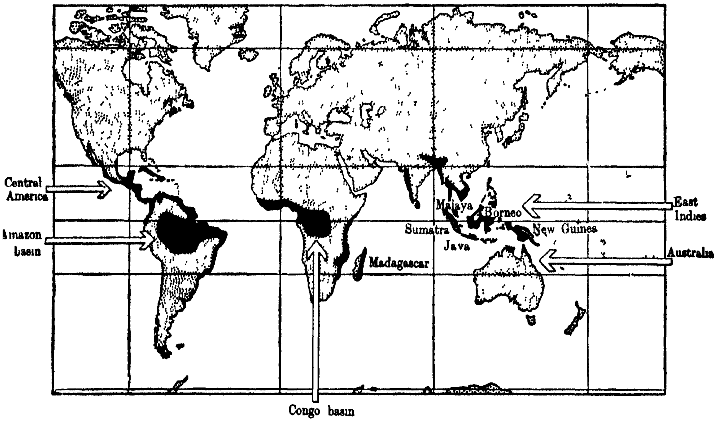

FIG. 37.—The Equatorial Climate. Map of the World showing the distribution of the equatorial type of evergreen forest, occurs also in wetter parts of tropical regions.

In the denser forests, animal life is almost restricted to the tree-tops and all orders of animal life can exhibit members specially adapted to their habitat. The monkeys are typical amongst mammals; tree-frogs with sucker-like feet are striking examples amongst the lower orders. In the Amazon Basin there is an amazing contrast between the deathly still, lifeless floor of the forest and the living, verdant surface of the canopy with its wealth of bird and insect life and its gaily coloured flowers. The South American selvas have so often been described that one hardly realizes that the African and Asiatic equatorial forests are scarcely of the same type. The tangle of ground vegetation makes the latter particularly difficult to penetrate, but the shafts of sunlight which reach the ground at intervals make the interior of these forests entrancingly beautiful.

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[1] Constant transpiration from the vegetation itself keeps the air moist, and the temperature even, but the constant partial condensation, almost as rain, causes the decay of vegetation near the ground.

The denser equatorial forests have been described as "Regions of Debilitation," since the damp, steamy heat causes man to degenerate. Such forests are very sparsely inhabited by backward races, stunted both physically and mentally and of which the American Indian tribes of the Amazon and the pygmies of the Congo are outstanding examples. The more open equatorial forests, where clearing is easier, and where Nature is bountiful in her gifts, are the home of many sturdy though lazy races. Of these the Malays, Javanese, and the Dyaks of Borneo are good instances.

There are certain marked difficulties in the clearing of equatorial forests. The trees are of extremely hard wood, difficult to cut down and difficult to burn; on the other hand, when once the forest is set alight the trees do not recover. A great danger is the rapidity with which vegetation springs up on cleared land. It is interesting to note that deserted clearings do not revert to the high forest but become choked by bamboo, rank grass, and weeds. Thousands of square miles of valuable high forest have been destroyed by native clearing in Africa and Asia and are now only occupied by useless bamboo and thorny thickets. Another danger in clearing equatorial forest, especially on hillsides, is that when the trees have been cleared away the torrential rains will completely wash away the soil and leave but a bare surface of rock.

When, however, equatorial forest has been successfully cleared and plantations well established, the regions are extraordinarily productive. Amongst the leading products are rubber, palm oil, cacao, and sugar. There is thus, at the present time, a marked contrast between:

(*a*) The undeveloped equatorial regions such as the Amazon and part of the Congo Basins; sparsely inhabited and almost useless, yielding only a little rubber or ivory; and

(*b*) The developed regions, notably Malaya and the East Indies, where development is the result of the enterprise of the white man, partly with the aid of local labour and partly with coloured labour from other regions. The most highly developed tracts are Malaya (the Federated Malay States and Straits Settlements) and Java.

Development is proceeding along the fringes of all areas; the region which is likely to defy longest man's activities is the great Amazonian Basin.

Fig. 37 shows approximately the distribution of the equatorial forest regions. This corresponds roughly with the area having an equatorial climate, except that the hot, wet forests extend also into the wetter parts of Monsoon lands and are interrupted by tracts of grassland in the drier parts of the equatorial belt.

THE TROPICAL CLIMATE

The Tropical Climate is found typically within the tropics and on either side of the equatorial belt. The adjective "tropical" is not very satisfactory, since it is used in a variety of senses. The Tropical Climate is therefore known also as the "Sudan Type" from its typical development in the Sudan of Africa; also as the Tropical Grassland Climate or the Savana Climate from the characteristic vegetation. Fig. 39, showing the distribution of tropical grasslands, indicates approximately where the climate is found. It must be observed that the region of tropical climate lies between the equatorial belt on the one hand and the hot deserts on the other. It is a transitional type between those two; on the one hand approximating to the equatorial climate, on the other to the climate of the hot deserts. As one moves away from the equatorial regions the range of temperature becomes greater, the rainfall decreases whilst its seasonal distribution becomes more marked. As the rainfall drops below 80 inches, high forest gives place to grassland with scattered trees, becoming poorer and sparser with decreasing rainfall until with a rainfall of about 15 inches the passage into desert occurs.

Temperature.—The average temperature of the wetter parts of the tropical belts is frequently lower than that of equatorial regions. This is what one would expect in view of the fact that one is farther from the equator. But in the drier parts, although actually farther from the equator, the moderating effect of rain is wanting, and the average annual temperature is higher. Still more striking is the increase in the range—from under 10° in wetter parts to upwards of 30° in drier parts.

Rainfall.—Most tracts of tropical grassland lie between equatorial forest on the one side and hot deserts on the other. The limits of the grassland are determined mainly by rainfall, which ranges from 70 or 80 inches per annum on the forest edge down to 10 or 15 inches on the desert borders. In the drier parts the reliability of the rainfall from year to year is important; in some years the fall is sufficient to ensure good crops, whilst in other years a poor rainfall results in famine conditions. The tropical grasslands lie in the Trade Wind Belts, and constant, strong winds are the rule in many areas. The most marked climatic feature, however, is the periodicity of the rainfall, the rain falling in the spring and summer of the year whilst the winter months are practically rainless. It is this seasonal distribution of rainfall which favours the growth of grass. Trees require a constant supply of moisture throughout the year; grass requires showers in the spring—the vegetative period—and early summer, but is indifferent alike to drought and scorching heat in the late summer or to drought and intense cold in the winter when the plants are resting.

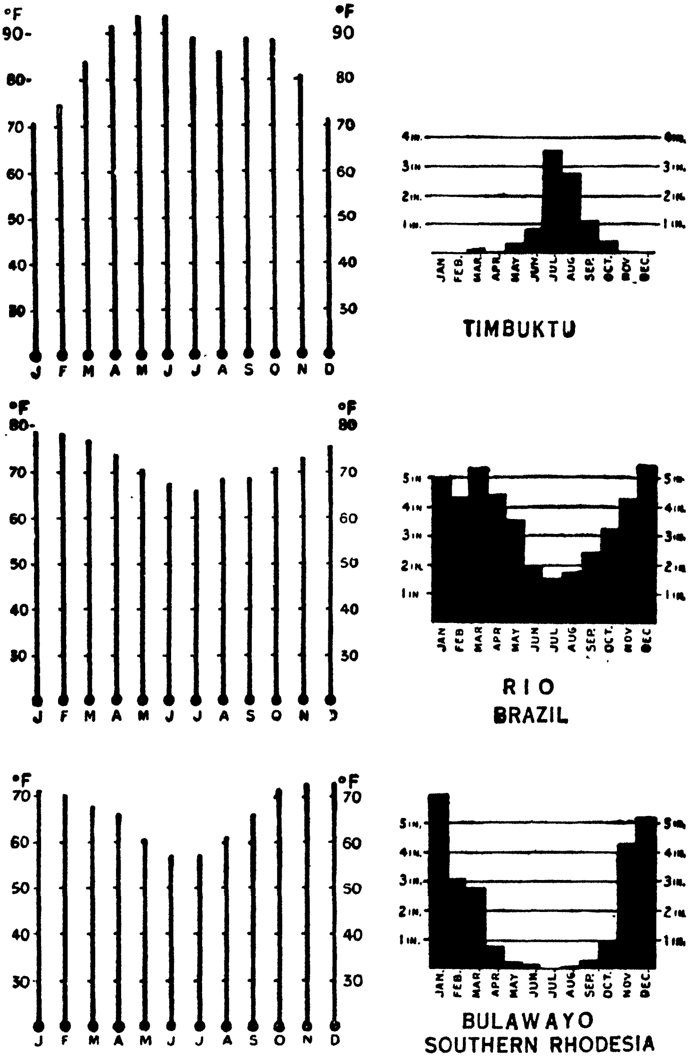


FIG. 38.—The Tropical Climate—Temperature and Rainfall Graphs.

The following stations have been chosen as typical of the tropical grassland. *Bismarckburg* (lat. 8° 10′ N.), 2,330 feet above sea-level, in Dahomey (West Africa), with a rainfall of 55 inches and so near the forest region. The lowering of temperature during the rainy season is very marked. *Bauchi* (lat. 10° 0′ N.), 2,200 feet above sea-level on the plateau of Northern Nigeria and with a very much lower rainfall. *Kuka* is further east, but closely comparable. *Timbuktu* (lat. 16° 37′ N.), where the grassland fades into desert, there being only 9 inches of rain per annum. *Bulawayo* (lat. 20° 2′ S.), 4,500 feet above sea-level on the healthy plateau of Southern Rhodesia, typical of the Southern Hemisphere. *Freetown* (lat. 8° 29′ N.). There are certain regions so far outside the equatorial belt that they have a marked summer rainfall climate, but with a rainfall much heavier than is usual in the tropical grasslands. Although there is a marked dry season, the rainfall is sufficient at other seasons to induce the growth of evergreen forest of equatorial type. Of such regions, Freetown (Sierra Leone (lat. 8° 29′ N.)), with 174 inches of rain, is quoted as an example. *Rio de Janeiro* (lat. 22° 57′ S.). Other stations near the coast, such as Rio, have the same marked periodicity of rainfall, but have a dry season which is not absolutely rainless.

TROPICAL CLIMATE—TEMPERATURE

Station	Height	Jan.	Feb.	Mar	April	May	June	July	Aug	Sept	Oct.	Nov.	Dec	Range
Bismarckburg	2329	77	**79**	78	76	75	72	70	*70*	71	73	76	77	9·1
Kuka (L. Chad.)	869	*71*	75	89	**92**	91	90	83	79	83	85	80	73	21·6
Timbuktu .	820	*71*	74	83	92	**94**	94	89	86	89	89	81	71	23 4
Bulawayo .	4470	71	70	68	66	61	57	*57*	62	66	71	72	72	15 0
Freetown . .	223	80	79	**81**	**81**	80	78	76	*75*	77	79	80	80	5 7
Rio de Janeiro	197	77	**78**	77	74	71	68	*67*	69	**69**	71	73	75	10 6

TROPICAL CLIMATE—RAINFALL

Station	Jan.	Feb.	March	Apr.	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Year
Bismarckburg	1·4	1·9	3 3	5 4	6·7	7 0	6 1	4 4	10 7	5 7	0 8	1 2	54 6
Bauchi	0	0	0 1	1 3	4 1	5 7	10 4	11 6	6 3	1 5	0	0	41 0
Timbuktu .	0	0	0 1	0	0 3	0 9	3·5	2 8	1 1	0 4	0	0	9 0
Bulawayo .	5 9	3 1	2 8	0 8	0·2	0 1	0	0 1	0 3	1 0	4·3	5 1	23·7
Freetown	.0 6	0 5	1 1	5 4	14 8	21·3	36 8	39 6	32 5	15 2	5 3	1 3	174 4
Rio de Janeiro	5 0	4 3	5 3	4 4	3 5	2 0	1 6	1·8	2 6	3 2	4 3	5 4	43 4

Natural Vegetation.—The characteristic vegetation of the Tropical Climate is a rich growth of tall grass with scattered trees. The grass springs up quickly during the rainy spring, but later in the year is scorched by the sun, and the country is dry and brown during the heat of late summer. Trees become more numerous and larger as the rainfall increases. Strong winds blow over many of the tropical grasslands and, by causing excessive transpiration, exert a deleterious effect on tree growth. As a result the trees are frequently umbrella-shaped, exposing only a thin edge to the wind. Grassland with scattered trees is known as Savana (Savannah or Savanna), a word which is commonly used as synonymous with tropical grassland. The resemblance of the Savana with its scattered trees to an English park has given rise to the use of the term "parkland." In South America local names such as "llanos" (Venezuela) and "campos" (Brazil) are used. Some of the tropical grassland forms very "difficult" country. The grass is often as much as 10 feet in height and travellers must use narrow paths, with the view obscured in all directions, and dangerous by reason of lurking animals. In the latter part of the year some of the coarser grasses have stems so thick and tough that, matted on the ground, they form a thicket more impenetrable than the liane encrusted equatorial forest. Over large areas the grassland may be devoid of trees.

The animals of the equatorial forests are specially adapted for climbing. Such adaptation would be of little use in grassland. Instead there are two main groups of animals:

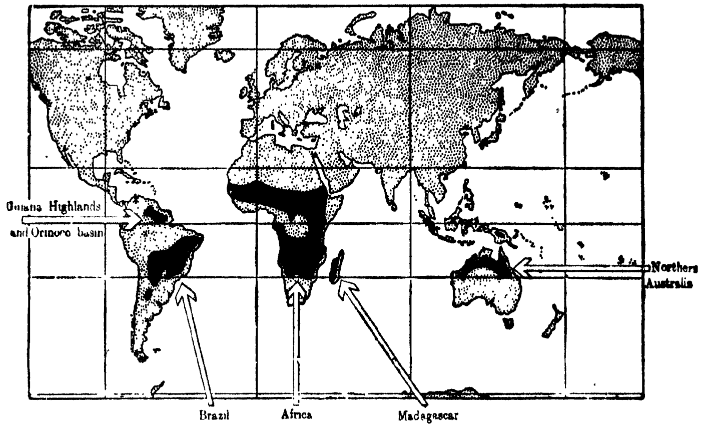


FIG. 39.—The Tropical Climate. Map of the World showing the distribution of the Tropical Grasslands. The wetter parts of lands with a tropical climate have forest as shown on Fig. 37.

(*a*) The swift-footed, vegetable-eating animals like the antelopes and giraffes, which find safety from their enemies in flight. Notice the special adaptation of the giraffe in a sparse grassland with tall trees.

(*b*) The carnivores, like the lion and leopard, which prey upon the members of the first group.

Man in the Savana may be primarily a hunter, but just as the grasslands support vast herds of wild grass-eating animals, so man is able to raise great herds of cattle, and man becomes a pastoralist; later an agriculturalist.

Development.—Few, if any, of the tropical grasslands are as yet fully developed. As grain displaces cattle in the temperate grasslands, so ranching is likely to become more and more important on the tropical grasslands. In some areas the natural grasses are too coarse to be of much immediate use, but there are vast areas in Angola, Northern and Southern Rhodesia, the East African Highlands, and elsewhere, of magnificent ranching country. Agriculture is likely to follow—maize and millets amongst the cereal crops; cotton and sugar amongst other cash crops, as well as groundnuts and other oil seeds.

THE TROPICAL MONSOON CLIMATE

The Tropical Monsoon Climate is very similar to the Tropical Climate, but the rainfall is caused in a different way. Both types are found mainly within the tropics, both have hot, rainy summers and dry, warm winters. But whereas the rainfall in the tropical grassland depends on the swing of the normal wind systems, that in Monsoon lands is due to a complete reversal of the normal wind system in the rainy season. The typical Monsoon lands are India, Indo-China, and Southern China. Central and Northern China and Japan are often called "Monsoon lands"; their rainfall is due to similar causes, but they lie outside the tropics, and have distinctly cold winters, thus necessitating their separation from the tropical Monsoon lands.

In winter the Monsoon lands are under the influence of the normal Trade Winds; but they lie on the fringes of great land masses, and in the early summer, when the sun is shining vertically over the land, it becomes greatly heated. The hot air tends to rise. and a great low-pressure area is formed. Moisture-laden winds from the ocean are drawn towards these low-pressure systems, and the "Monsoon winds" so caused bring copious rains. The reversal of the winds and the arrival of the rain is known as the "break of the monsoon." It will be observed that the word "monsoon" is used in several senses. It comes from an Arabic word meaning "season," and is often used as equivalent to the rainy season by residents in India. Geographers more frequently use the word to denote the winds of Monsoon lands, both the rain-bearing wind and the dry season wind which is the normal Trade Wind. In India, which may be regarded as the typical Monsoon land, there are thus three seasons:

(*a*) The cool season, with little rain, from November to about January.

(*b*) The hot season, when the land becomes heated up, and there is no rain, from about February to the beginning of June.

(*c*) The rainy season, when the heavy rains cool the atmosphere, and the temperature is lower, from about the middle of June to October.

The Monsoon Climate occurs around the Indian Ocean, especially in India, Burma, Indo-China, North-Western Australia, and part of the East African coast. In the Southern Hemisphere the seasons are, naturally, reversed; Darwin has been chosen as an example. A monsoon effect is also found on the coastal margins of North-Western South America, and Eastern Brazil, and Central America, whilst much of the heavy rainfall of the Guinea Coast in Africa might be described as monsoonal.

Temperature.—Generally speaking, the drier the place the less the cooling influence of the rain is felt, and the greater the range of temperature. There is thus a very large range in the Punjab (North-West India). The wetter places, on the other hand, and those under the influence of the sea, have a much smaller range of temperature. Bombay is a good example. Notice that in October, when the rains are drying up, there is a slight rise in temperature.

Rainfall.—The rainfall in Monsoon lands depends largely on relief. Where the monsoon comes in contact with high mountains near the coast, and is forced to rise, the resulting rainfall is very great. Average annual falls of over 500 inches are known, and such exposed positions may be classed as the rainiest in the world. On the other hand, near the low-pressure centre in India, towards which the winds blow for great distances over land, they arrive practically dry, and certain stations have less than 5 inches of rain per year. Stations in the drier, northern parts of India, such as Lahore and Delhi, get a little rain in the winter from winter cyclones.

It will be found later that Monsoon lands are conveniently divided into four parts:

(*a*) Areas with more than 80 inches of rain—areas which are normally clothed with evergreen forest of equatorial type.

(*b*) Areas with between 40 and 80 inches of rain—areas where the deciduous Monsoon forests flourish, the trees losing their leaves in the hot, dry season.

(*c*) Areas with between 20 and 40 inches—covered with scrubland and thorn forest.

(*d*) Areas with less than 20 inches—forming deserts and semi-deserts.

The variation in rainfall in the tropical Monsoon lands is thus remarkable.

TROPICAL MONSOON CLIMATE—TEMPERATURE

Station	Height	Jan.	Feb.	Mar.	Apr	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Lahore . .	702	*53*	67	69	81	89	**93**	89	87	85	76	63	55	40
Bombay . .	37	*75*	75	78	82	**85**	82	79	79	79	81	79	76	10·1
Darwin . .	97	84	83	84	84	82	79	*77*	79	83	85	**86**	85	8·5

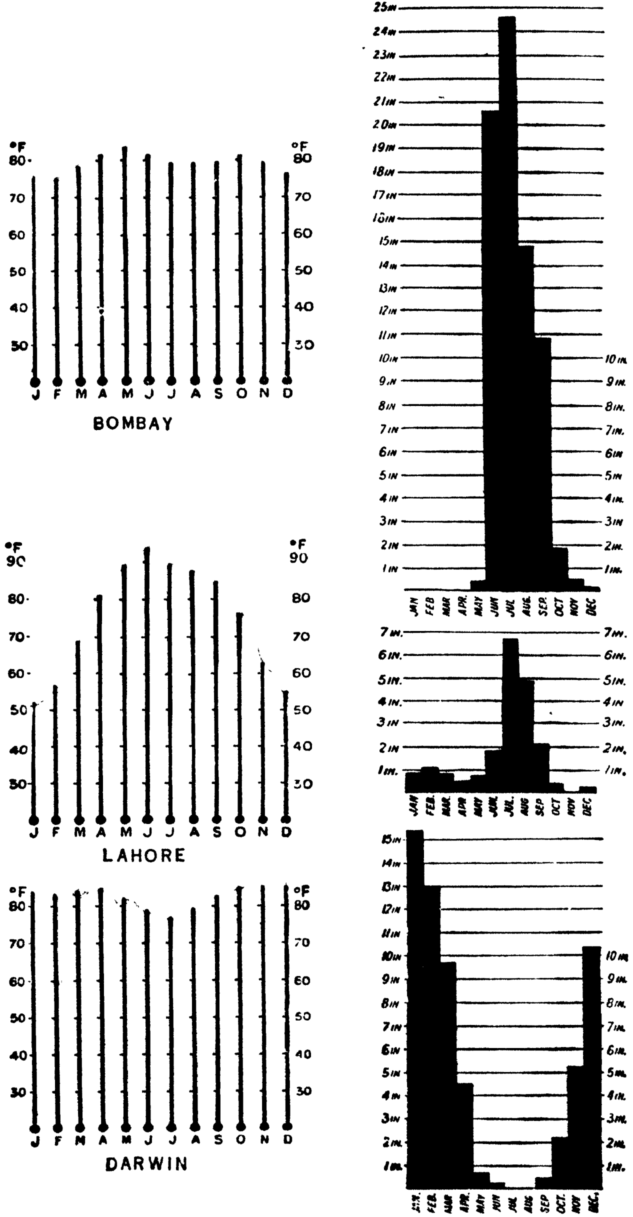


FIG. 40.—The Tropical Monsoon Climate—Temperature and Rainfall Graphs

TROPICAL MONSOON CLIMATE—RAINFALL

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Lahore	0·9	1·1	0·9	0·5	0·8	1·9	6·7	4·9	2·1	0·4	0	0·3	20·5
Bombay	0·1	0	0	0·1	0·5	20·6	24·6	14·9	10·9	1·8	0·5	0·1	74·1
Darwin	15·3	13·0	9·7	4·5	0·7	0·2	0·1	0·1	0·5	2·1	5·2	10·3	61·7

Vegetation.—It will be gathered, from what has already been said, that the natural vegetation of the Tropical Monsoon Climate is forest or woodland, and that the resting season is the hot, dry period of the year. It is at that time that the trees need to guard against excessive loss of moisture, and they do so by shedding their leaves. In the wettest parts, however, where the rainfall is more than 80 inches per year, the subsoil remains moist throughout the year, with the result that the forests are evergreen, though more open than the true equatorial forests. Where the rainfall is between 40 and 80 inches the true Monsoon forests flourish, consisting of fine large trees of which teak and sal are the most familiar. It must be remembered that there are numerous species in these forests, and that a teak forest includes many other trees besides teak. As the rainfall gets less and less, the trees become smaller, and many of them are armed with thorns. The true forest thus passes into thorn forest and scrubland. The trees are separated by bare patches which may, during the rains, become covered with

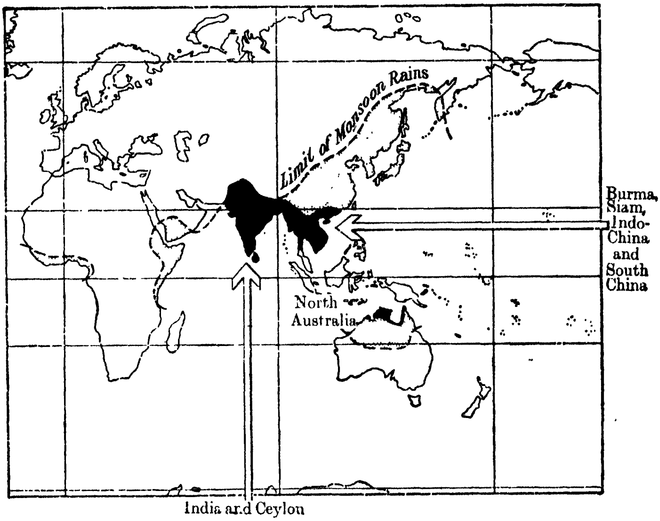


FIG. 41.—Map showing the principal Monsoon lands.

Note the distinction between the area (shown in black) with a true Tropical Monsoon Climate and the area (stippled) where the rainfall is of monsoon type.

grass, at which seasons the scrubland of India closely resembles the Savana or tropical grassland of Africa. Finally the scrubland passes into desert with only a few scattered thorny or milky plants.

Development.—Monsoon vegetation is more easily cleared than equatorial forest. Only in the wetter situations on hillsides is there danger of heavy rains washing away the soil.

The Monsoon Climate is very favourable to the growth of food crops which, like the natural vegetation, vary with the rainfall. Rice is the characteristic grain of the wetter parts; millet and sesamum of drier parts, whilst wheat and barley flourish as winter crops in the cooler, drier regions. Maize and various oil seeds flourish in the intermediate areas, cotton in the drier parts, sugar in the wetter. Once the land is cleared a comparatively small effort on the part of man secures an abundant return. Accordingly the Monsoon lands are amongst the most densely populated in the world, the population tending to be largely agricultural and to be concentrated in those areas where the soil is richest. Northern Australia is practically the only undeveloped portion of the Monsoon lands. In contrast to the equatorial regions, Monsoon regions have been called " Regions of Increment."

THE HOT DESERT CLIMATE

Passing from the regions of the Tropical Climate towards the poles, we find lands which are very hot and very dry. They lie mainly along the high-pressure belts which encircle the globe just outside the tropics. In these high-pressure belts the currents of air are descending and the winds blow *outwards* (especially in winter)—towards the equator as the Trade Winds and towards the poles as the Westerly Winds. In summer these regions of great heat and dryness may be regions of low pressure. Any inblowing winds, however, do not give up their moisture owing to the heat, except in the form of dew at night or during occasional violent thunderstorms. There are few clouds by day, and the sun pours down with unmitigated force on the unprotected soil, whilst the absence of cloud at night permits rapid radiation of heat, so that the nights are often very cold. Similarly there is a big contrast between the hot season, when the sun is almost vertically overhead, and the cold season. There is little or no rain to exercise a cooling influence on the temperature. It should be noticed that on the *west* sides of the continents, where the S.E. or N.E. Trade Winds are blowing *off shore*, the moderating influence of the sea is apparent in the smaller range of temperature, but stations right on the coast (*e.g.* Walvis Bay, S.W. Africa) may be practically rainless, and the hot deserts of North and South Africa, Australia, Asia, and South America extend right to the ocean. The highest temperatures of the world are recorded in these regions. The land masses are broader in the Northern Hemisphere, with the result that the deserts are larger. A great continuous area of desert stretches across North Africa from the Atlantic to the Red Sea (Sahara Desert, whence this type of climate is often called the Sahara type) across Arabia, over the borders of Persia into Baluchistan and the great Indian Desert. The latter is really the driest part of the Monsoon lands. In North America, the continent at these latitudes is narrower, and the greater elevation causes the deserts of Mexico and the south-western United States (Colorado) to be less extreme in character. In South America the Atacama and Peruvian Deserts occupy the narrow strip between the Andes and the Pacific Ocean. In South Africa the Kalahari Desert extends right to the Atlantic Ocean, where the driest part is known as the Namib. In Australia a very large area has a rainfall of less than 10 inches per annum. It should be noted that on the east sides of the continents the Trade Winds blow from the sea towards the land and deserts are characteristically absent from the east sides of the continents. The importance of mountain ranges in preventing the winds from penetrating into the interior is particularly well seen in Australia, South Africa, and South America.

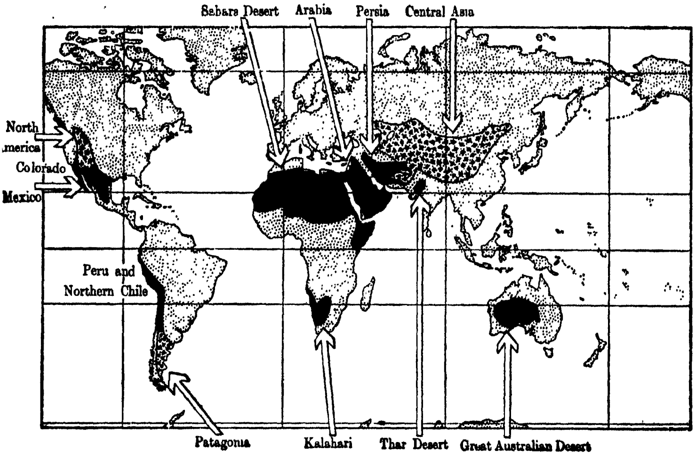


FIG. 42.—Map showing the distribution of Hot Deserts (in black) and Temperate Deserts (large dots).

Temperature.—*El Golea*, in the Sahara, is chosen as typical of an inland desert station with a big range of temperature. *Jacobabad*, in the Indian Desert, has one of the highest recorded average monthly temperatures—nearly 98° in June. *Iquique*, on the coast of South America, has a rainfall of only 0·05 inch per annum, but the influence of the sea gives a temperature range of only 11°.

Rainfall.—It should be noted that the periodicity of what rainfall there is in the hot deserts varies according to the position of the station concerned. On the equator-ward margins, where the deserts pass into tropical grasslands, the scanty rainfall comes in summer; on the poleward margins, where the deserts fade gradually into Mediterranean scrubland, the rain comes in winter. Timbuktu, with a total rainfall of 9 inches, has already been considered as an area of very dry tropical grassland; Cairo, with 1·3 inches of rain per year, falling between October and April, is an example of the second class.

In desert regions, the unreliable nature of the scanty rainfall is also noteworthy. Years may elapse with no rain at all; the "average" figure being the result of a few heavy showers at intervals of years.

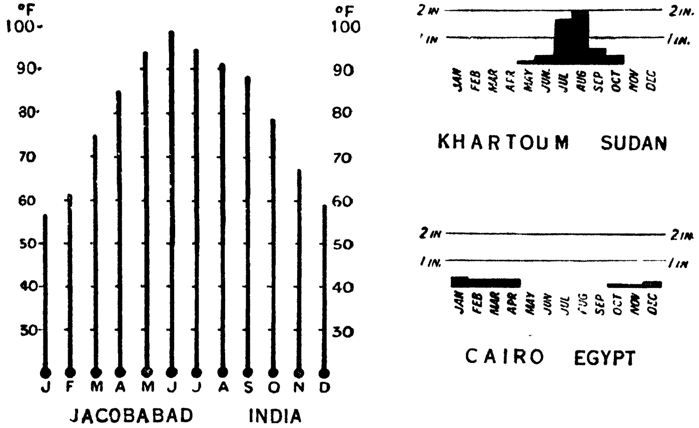


Fig. 43 —The Hot Desert Climate—Temperature and Rainfall Graphs.

HOT DESERT CLIMATE—TEMPERATURE

Station	Height	Jan	Feb	Mar.	Apr.	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Range
El Golea .	1257	***49***	**54**	61	70	77	88	**93**	91	85	72	59	50	44
Jacobabad .	186	*57*	62	74	85	94	**98**	95	92	89	79	67	59	40
Iquique . .	30	**71**	71	69	65	63	62	*60*	61	62	64	67	69	11

HOT DESERT CLIMATE—RAINFALL

(1) Mediterranean Margin.

Station	Height	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Year
Cairo .	98	0·3	0·2	0·2	0·2	0	0	0	0	0	0·1	0·1	0·2	1·3

(2) Tropical Margin.

Station	Height	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Year
Khartoum	1280	0	0	0	0	0·1	0·3	1·7	2·0	0·5	0·3	0	0	4·9

Natural Vegetation.—From the point of view of natural vegetation hot deserts may be regarded as falling into two divisions:

(*a*) The portions bordering the tropical grasslands are really very, very poor grassland.

(*b*) The portions bordering the Mediterranean regions are really very, very poor scrubland.

There are few deserts where absolutely *nothing* grows. Desert plants have different means of storing water. Some of them have very long roots which go down to great depths, and these reach water; many have fleshy stems and leaves in which they can store up water; in many the stems and leaves are covered with a thin coating of wax, which prevents loss of water by excessive transpiration, whilst nearly all are armed with sharp spines and thorns which prevent them from being eaten by animals.

Of special importance are the fertile areas, usually occupying hollows, which result when underground supplies of water come sufficiently near the surface to be accessible to vegetation. Some of these oases consist merely of a clump of palms surrounding a pool or well or small spring of water. The most typical tree is the date palm. Other oases are many hundreds of square miles in area, and, being very fertile, support a considerable population.

It is interesting to note the special adaptations of desert animals. Although few in number, they are usually of a dull-brown colour, which exactly matches the sand and prevents them from being seen. The most characteristic animal is the camel, exhibiting a double adaptation against shortage of drinking water and, by the broadening of the foot, against sinking in the sand.

Development.—There are three classes of inhabitants in the desert:

(*a*) The wanderers who move with their camels from place to place, and who either act as carriers of goods from one desert margin to another, or who form bands of nomadic robbers.

(*b*) The settled population of the oases who devote themselves to growing grain and rearing cattle, and especially to the cultivation of the date palm.

(*c*) A settled population of miners attracted by mineral deposits which occur independently of climatic conditions. Examples are the nitrate fields of Chile and the goldfields of Western Australia.

The influence of environment on the habits and habitations of desert folk is interesting. They have little to see except the vast expanses of rocky and sandy waste—so the desert produces a philosophical outlook. The need of a knowledge of the stars for night guidance has produced peoples learned in mathematics and astronomy. The ancient Egyptians and Arabs are examples.

The wanderers live mainly in tents, but the dwellers in the oases build houses with thick stone walls for coolness and flat roofs because of the absence of rain. The larger oases, such as those of Arabia, have acted in a remarkable way as reservoirs of people. They are capable of supporting a large population so long as the water-supply is available. But should the springs fail, the people are faced with starvation, with the result that large bands leave in search of fresh homes, and never return. The migrations of the Arabs in the Middle Ages can be traced to such causes; as can the arrival of the Shepherd Kings in Egypt from Arabia, or the journeying of Abraham which led him to settle in the Promised Land.

It is to be noted that in many cases the soil of desert lands is a fine alluvial dust, and when water is available for irrigation may become exceptionably fertile. The Nile Valley in Egypt is a special example, as the Nile flows in a narrow, trench-like valley cut in the surface of the desert, but the extensive crop-lands in the Colorado Desert of America and in the Indus plains of India are characteristic examples of desert irrigation.

The importance of deserts as barriers to human intercourse and migration is worthy of particular note. The Sahara, separating the white and negro races of mankind, is an excellent example

THE MEDITERRANEAN CLIMATE

One of the most distinctive and best known of all the climatic types is that known as the Mediterranean, from its occurrence in the lands surrounding the Mediterranean Sea. The fact that the belt of vertical sunshine moves northwards and southwards from the equator, so that the main wind belts of the world swing with it, is already familiar. There are parts of the earth—roughly between latitudes 30° and 45°, which in summer are in the Trade Wind Belt, or more correctly in the High-Pressure Belt from which the Trade Winds arise. Like the hot deserts which border them on the side nearer the equator, these regions are hot and dry in the summer, with outblowing winds. In winter, however, these regions come under the depressions of the Westerly Wind Belt and so enjoy moist, mild winters. In other words, this is the "Winter Rain Climate." Contrasted with the typical "Summer Rain Climates"—the Tropical and Monsoon—it must be remembered that the Mediterranean is a temperate climate and essentially cooler. Another characteristic of the Mediterranean Climate is the large amount of sunshine. Almost cloudless skies are the rule in summer, and even in winter clouds are less numerous than would be expected. Like the Hot Desert type the Mediterranean Climate is restricted to the *western* sides of the continents where, during the hot summer, the

Trade Winds are blowing *offshore*. A little reflection will show that the Mediterranean type of climate could scarcely exist on the eastern sides of the continents, where the Trade Winds blow from the oceans and are moisture laden.

The largest area of Mediterranean Climate is that found all round the Mediterranean Sea. Other areas occur in, roughly, the same latitudes in North America (California), South America (Central Chile), South Africa (south-west of Cape Colony), and Australia (south-west of West Australia, South Australia, and part of Victoria).

Temperature.—There are great local variations in temperature, but the winters are invariably mild—the coldest month has an average temperature of over 40°, and in very large tracts over 50°—and the summers are both hot and dry with a mean temperature for the hottest month of over 70°, and in many areas over 80°. The chilliness of winter days is largely compensated by the bright sunshine.

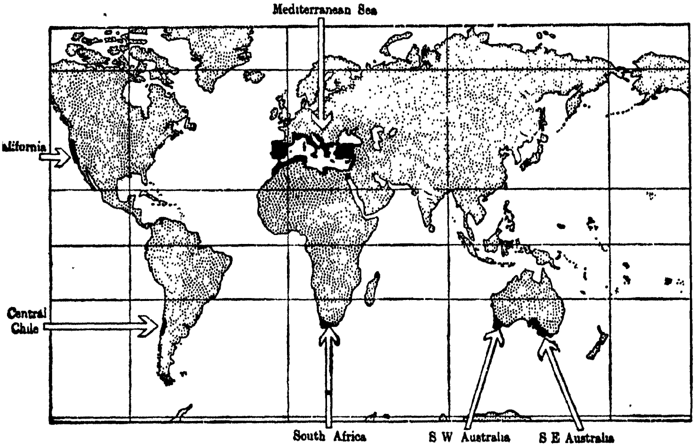
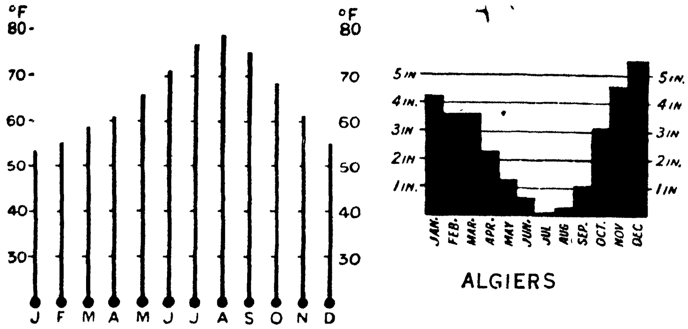


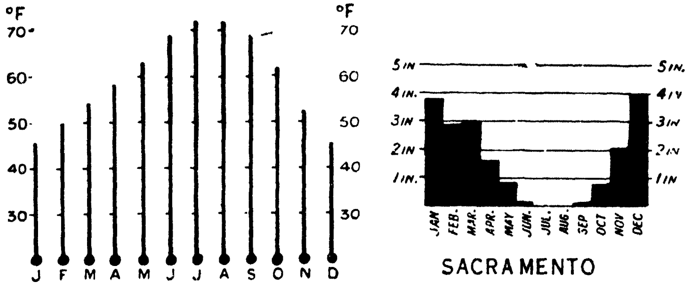
FIG. 44.—The Mediterranean Climate. Map of the World showing the principal Mediterranean lands.

Nice has been chosen as typical of the well-known Riviera—towards the north of the Mediterranean region. *Rome* is slightly inland and shows the importance of distance from the sea. *Madrid*, on the high Spanish meseta, shows wide variations from the normal; whilst *Algiers* is typical of the western part of the North African coast, and *Alexandria* of the dry eastern Mediterranean.

In North America there is a marked contrast between the foggy Californian coast and the dry sunny Californian valley—

San Francisco and *Sacramento* illustrate the two types. *Perth*





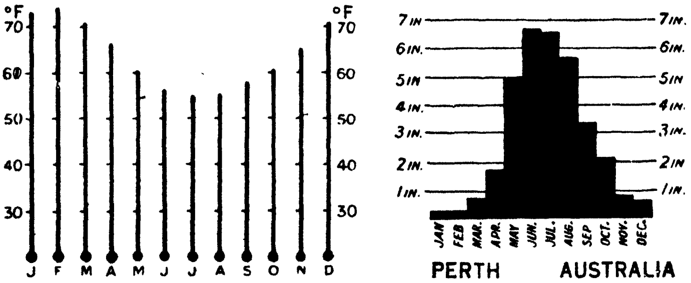


FIG. 45.—The Mediterranean Climate—Temperature and Rainfall Graphs.

may be taken as an example of a station near the sea in the Southern Hemisphere.

Rainfall.—The rainfall of the Mediterranean varies greatly in amount, mainly according to local physical factors. One constant feature is the periodicity, another the small number of days on which the rain falls. This accounts for the numerous sunny days even in the wet winter. Rome, for example, has an average of four hours' sunshine per day in the least sunny month. The typical rainfall may be taken as between 10 and 40 inches. A fall of between 25 and 30 inches in the year characterizes such typical regions as the Riviera, Naples, Palermo, and Barcelona. The Californian valley and Central Chile are somewhat drier. Where the rainfall drops below 10 inches the Mediterranean lands fade into desert regions. Such areas as the deserts of Northern Africa and Syria are really very dry Mediterranean regions. In normal Mediterranean areas rainfalls of more than 60 inches per year are unusual, though falls of over 100 inches may occur in exposed situations.

MEDITERRANEAN CLIMATE—TEMPERATURE

Station	Height	Jan	Feb	Mar	April	May	June	July	Aug	Sept.	Oct	Nov	Dec.	Range
Nice . . .	66	*46*	48	51	56	62	69	**74**	73	68	61	53	47	27·4
Rome . .	164	*44*	47	51	57	64	71	**77**	76	70	62	52	46	32·5
Madrid . .	2149	*40*	44	47	52	59	68	**76**	75	66	55	47	40	36·0
Salonika . .	7	*41*	45	50	57	67	74	**79**	78	72	64	52	45	38·2
Algiers . .	72	*53*	55	58	61	66	71	77	**78**	75	68	62	56	24·1
Alexandria .	105	*57*	60	63	66	71	76	79	**81**	79	75	68	61	23·0
San Francisco	207	*49*	51	53	54	55	57	57	58	**59**	58	55	51	9·8
Sacramento .	71	*46*	50	54	58	63	69	**72**	72	69	62	53	46	26·9
Cape Town .	40	69	**70**	68	63	59	56	*55*	56	57	61	64	67	14·9
Perth . .	197	73	**74**	71	66	60	56	*55*	56	58	61	65	71	19·1

MEDITERRANEAN CLIMATE—RAINFALL

Station	Jan	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct	Nov.	Dec	Year
Nice . . .	2·8	2·2	2·7	3·5	3·2	1·8	0·4	1·0	2·6	6·3	4·4	2·8	33·7
Rome . .	3 1	2·4	2·7	2·6	2 2	1·5	0·7	1·1	2·9	4·5	4·4	3·6	31·7
Madrid . .	1·3	1·1	1·8	1·9	1·8	1 1	0·5	0·5	1·3	1·8	1·9	1·6	16·6
Athens . .	2·0	1·5	1·3	0·8	0·8	0·7	0·3	0·4	0·6	1·7	2·9	2·4	15·4
Algiers . .	4·2	3·5	3·5	2·3	1·3	0·6	0·1	0·3	1·1	3·1	4·6	5·4	30·0
Alexandria .	2·2	0·9	0·5	0·2	0	0	0	0	0	0·3	1·4	2·6	8·1
San Francisco	4·8	3·6	3·3	1·7	0·7	0	0	0	0·3	1·0	2·6	4·7	22·7
Sacramento .	3·8	2·9	3·0	1·6	0·8	0·1	0	0	0·2	0·9	2·1	4·0	19·4
Cape Town .	0·7	0·6	0·9	1·8	3·9	4·4	3·5	3·3	2·2	1·6	1·1	0·8	24·8
Perth . .	0·3	0·3	0·7	1·7	4·9	6·6	6·4	5·6	3·3	2·1	0·8	0·6	33·3

Natural Vegetation.—In the Mediterranean Climate with its mild, moist winter and hot, dry summer, the plants need to utilize the water which accumulates during the winter, and have to protect themselves against loss of moisture during the hot summer. The climate does not favour shallow rooting herbs and grass which require light showers during the spring and early summer. The vegetation of Mediterranean lands consists, therefore, chiefly of small evergreen trees and shrubs. A ground vegetation of flowering shrubs and herbs takes the place of grass. Many of them have small, leathery leaves, or leaves with a surface coating of wax (as in the orange); others, such as the olive, have leaves covered with fine silky hairs. All these devices prevent excessive transpiration. Many of the plants, such as the vine, have exceptionally long roots. Aromatic plants are also very characteristic. In the wetter parts of Mediterranean lands fine forests may occur, of which the cork-oak forests of Europe and the jarrah forests of Australia are examples. The thick bark of the cork-oak is itself a protection against loss of moisture. The bright, sunny conditions in Mediterranean lands are ideal for the ripening of fruit. There are the citrus fruits (oranges, lemons, and grape-fruit), a great variety of deciduous fruits (peaches, nectarines, and apricots) as well as the vine with its many varieties, the olive, almond, fig, and mulberry trees. Of grains, the harder types of wheat and barley grow well, sowing and reaping being adapted to the exigencies of the climate. In moister, interior valleys, somewhat away from the typical Mediterranean coastlands are to be found chestnut forests, whilst plums, pears, and apples flourish in cultivation.

Development.—The delightful, sunny climate of Mediterranean lands, favourable to man and plants alike, has harboured many of the great civilizations of the world—Greece and Rome and Carthage. But the ease with which food is obtained, and the spirit of *laissez faire* engendered by the balmy clime, may easily be a disadvantage. Though resting in the heat of the day, the Mediterranean farmer is, however, a hard worker and is much pre-occupied with irrigation. Outside of Europe the attractiveness of the Mediterranean Climate is very marked. Population maps of South America, South Africa, and Australia in each case show a very marked concentration in the Mediterranean areas. Still more noteworthy is the agricultural development of California.

Architecture has followed the dictates of climate. The shady piazzas of Italy, the thick-walled stone houses with shaded balconies —so desirable for the noontide siesta—are evidence of this. In the drier areas the flat-topped houses draining *inwards* to a cistern emphasize the value of water. The dweller in rainier climes is only too anxious to throw off his rain water on to his neighbour's land.

THE WARM TEMPERATE EAST COAST CLIMATE

Reference has already been made to the fact that the Mediterranean Climate occurs on the western sides of the continents. On the eastern sides, in the same latitudes, there are regions in which the temperatures are roughly comparable, but in which the rainfall comes mainly in summer. The regions to be considered are the very important South-Eastern States—the Cotton Lands and Florida in the U.S.A.—the greater part of China in Asia, the south-eastern coastlands of Australia and South Africa, and the region of Uruguay and South-Eastern Brazil in South America. Although comparable in certain broad respects, these regions have not a single type of climate in the sense that the Mediterranean is a single type; each region is strongly influenced by the major physical features of the individual area.

The South-Eastern States owe their rainfall to the North-East Trade Winds and to the moisture-laden winds from the Gulf of Mexico which are drawn inwards by the low-pressure centre which forms over the heart of the continent in summer. There is a moderate rainfall throughout the year, usually with a maximum in the latter part of the summer. This "Gulf Type," of which Galveston and Raleigh may be given as examples, may be considered as bounded on the west by the 20-inch rainfall isohyet (the limit for cotton is 23 inches) and on the north by the January isotherm of 40°. The cotton belt is bounded by the line marking the limit of the area with 200 or more frostless days. Most of the region so defined has between 40 and 60 inches of rain.

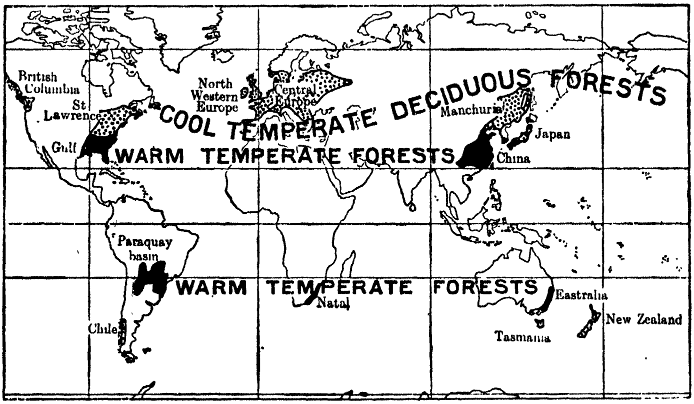
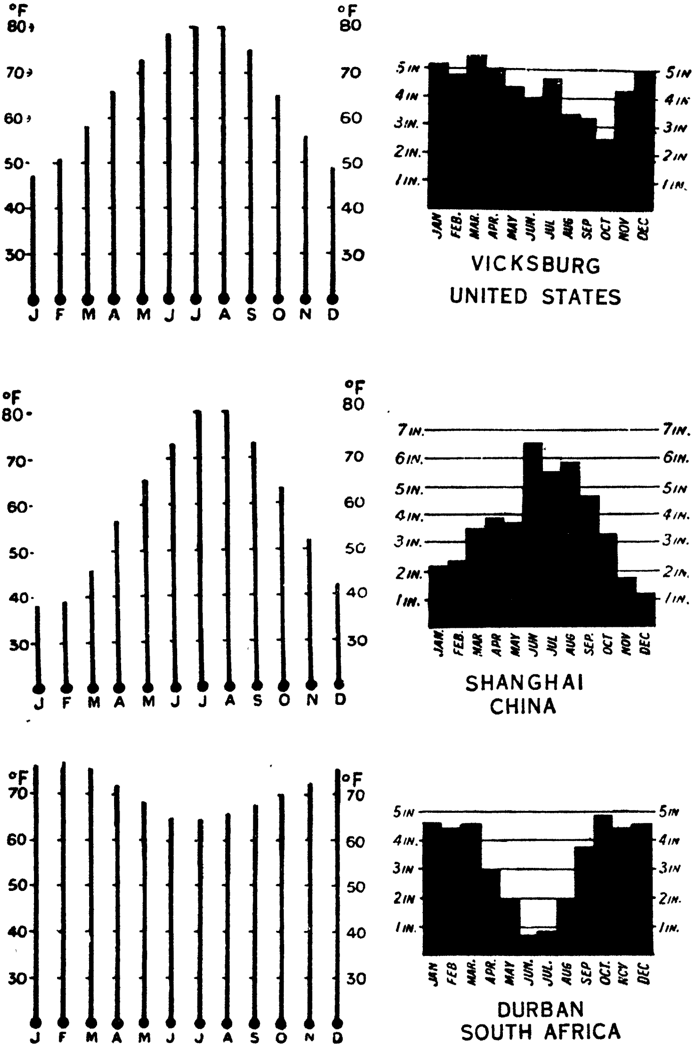

British Columbia
St Lawrence
Gulf
North Western Europe
Central Europe
COOL TEMPERATE DECIDUOUS FORESTS
Manchuria
Japan
China
WARM TEMPERATE FORESTS
Paraquay basin
Chile
WARM TEMPERATE FORESTS
Natal
Eastralia
Tasmania
New Zealand

FIG. 46.—Map showing the distribution of the Temperate Forests, occupying areas having the Warm Temperate East Coast Climate (in black); the Cool Temperate Oceanic Climate and the St. Lawrence Type of Climate (both marked by large dots).

Central and Northern China form part of the great Monsoon region of Asia, but the Climate differs from that of India and Southern China (Tropical Monsoon Climate) in the coldness of the winters. The rainfall, like that of India, is due to the development of a low-pressure centre in the heart of Asia, towards which rain-bearing winds from the ocean blow. Whilst India is protected in winter from the cold outblowing winds from the heart of Asia by the mountain barrier of the Himalayas, China is not so fortunate. The January isotherm of 32° almost reaches the Tropic of Cancer; snow is common in winter, even on the plains. The essentially summer rainfall is greatest near the coast. Shanghai near the coast and Peking, further north and more inland, have been chosen as examples of the "China Type."



VICKSBURG
UNITED STATES

SHANGHAI
CHINA

DURBAN
SOUTH AFRICA

Fig. 47.—The Warm Temperate East Coast Climate—Temperature and Rainfall Graphs.

Vicksburg does not show the usual late summer rainfall maximum of the Gulf type.

In the Southern Hemisphere the "Eastralian" type enjoys a rainfall fairly well distributed throughout the year, but with a summer maximum. It is derived mainly from the normal Trade Winds. In Australia and South Africa the climatic type is restricted to limited coastal areas; in South America there is a marked tendency for the winds to be drawn up the Parana River basin by the summer low-pressure area of the interior. In the Southern Hemisphere, especially in South Africa and Australia, where land masses are so much smaller, the range of temperature of east coast stations is much smaller than in the Northern Hemisphere.

WARM TEMPERATE EAST COAST CLIMATE—TEMPERATURE

Station	Height	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec.	Range
Galveston	69	*54*	56	63	70	76	82	**84**	83	80	72	63	56	30·0
Vicksburg	247	*47*	51	58	65	73	78	**80**	80	75	65	56	49	33·4
Raleigh	390	*40*	43	50	59	68	75	**78**	77	71	60	50	43	38·1
Shanghai	33	*38*	39	46	56	65	73	**80**	80	73	63	52	42	42·8
Peking	131	*23*	29	41	57	68	76	**79**	76	68	54	38	27	55·3
Brisbane	137	**77**	76	74	70	64	60	*58*	61	65	70	73	76	19·1
Durban	260	77	**77**	76	72	68	65	*65*	66	68	70	73	**75**	12·0

WARM TEMPERATE EAST COAST CLIMATE—RAINFALL

Station	Jan.	Feb.	Mar	April	May	June	July	Aug	Sept.	Oct	Nov.	Dec.	Year
Galveston	3·4	3·0	2·9	3·1	3·4	4·2	4·0	4·7	5·7	4·3	3·9	3·7	46·3
Vicksburg	5·2	4·8	5·5	5·0	4·3	4·0	4·6	3·4	3·3	2·6	4·3	5·0	52·0
Raleigh	3·1	4·2	4·2	3·4	4·6	4·6	5·4	6·1	3·7	3·1	2·4	3·2	48·0
Shanghai	2·2	2·3	3·4	3·8	3·7	6·5	5·5	5·9	4·7	3·2	1·7	1·2	44·0
Peking	0·1	0·2	0·2	0·6	1·4	3·0	9·4	6·3	2·6	0·6	0·3	0·1	24·9
Brisbane	6·7	6·7	6·1	3·7	3·0	2·6	2·3	2·4	2·1	2·7	3·7	5·1	47·0
Durban	4·6	4·5	4·6	3·0	2·0	0·7	0·8	2·0	3·7	4·9	4·4	4·5	39·7

Natural Vegetation.—The differences in the climate of the several areas now under consideration are reflected in the natural vegetation. In general it may be said that high forest is typical; evergreen where the rainfall is sufficiently well distributed. These "warm temperate rain forests" often exhibit a luxuriance of growth rivalling the equatorial forests, but they are more open. Palms and tree ferns are noteworthy in most areas.

Development.—These areas are eminently suited for human occupation and development. The valleys of Central China, with their rice, cotton, tea, and silk, resemble Monsoon India in their density of population; the Gulf States of America are the world's great storehouse of cotton with the Maize Belt immediately to the north. The eastern coastal strip of Australia and the warm coastal belt of Natal have both attracted a large population. There are considerable untouched forest areas, however, in South America—untouched largely because they are swampy and unhealthy.

COOL TEMPERATE OCEANIC CLIMATE

We now return to the western margins of the continents and consider the climate found on the poleward side of Mediterranean lands. These regions lie constantly in the Anti-Trade Wind Belt—under the influence of cool, rain-bearing winds from the ocean the whole year. The two characteristics—small range of temperature and well-distributed rainfall—are at once obvious. The Anti-Trade Winds do not blow as steadily as the Trade Winds, but rather as a succession of eddies and whirls known in geographical parlance as cyclones and anti-cyclones. Residents in North-Western Europe know well the prime importance of the cyclones or anti-cyclones in determining the local weather.

British Columbia and the north-western United States have this type of climate, but the largest area is North-Western Europe. In the Southern Hemisphere there is a small area in Southern Chile, but no part of Africa lies sufficiently far south, whilst in Australasia only Tasmania and the south island of New Zealand are typical. In North America marked local variations are due mainly to the disposition of the mountain ranges, which, running parallel to the coast, prevent the rain-bearing winds from penetrating far inland. In British Columbia parts of the interior plateaux amongst the Rocky Mountains have thus an annual rainfall of less than 5 inches per annum, whereas exposed stations on the coast have over 80 inches. Many stations in this tract, as in the Mediterranean region to the south, have a marked rainfall maximum in winter.

In Europe, owing to the influence of the North Atlantic Drift, the mild winters characterizing this type of climate extend exceptionally far north. Conditions are most truly oceanic, *i.e.* the annual range of temperature is least, near the western coasts. Winters become steadily colder as one goes eastwards and the summers slightly warmer. It is customary in Europe to separate two subdivisions:

(*a*) North-West European type, where the average temperature of the coldest month is above freezing—averaging about 40°.

(*b*) Central European type, where the average temperature of the coldest month is about or below freezing.

The temperature for the hottest month lies between 55° and about 75°, with 65° as an average figure.

The rainfall shows, on the whole, a steady decrease from exposed situations on the west coasts of France and the British Isles, where it may be over 80 inches, towards the east, ranging as low as 18 inches in Eastern Germany. Between 20 and 30 inches may be regarded as normal for the greater part of the area. More than 40 inches is excessive for many crops. The actual amount is determined largely by local physical factors. The rainfall is well distributed throughout the year, with a tendency to a maximum in late summer.

Of the figures given below, Valencia is an example of an essentially maritime station on the west coast of Ireland; Nantes or

Brest of North-Western France. London lies in the drier east of England. Paris shows slightly more continental influence. Hamburg may be regarded as on the borderline between North-Western and Central Europe. Berlin is Central European; Vienna is still more markedly continental. In North America Vancouver is on the coast; whilst Kamloops shows the remarkable effects in a station cut off by mountains from the moderating influence of the ocean and its rain-bearing winds. Dunedin (New Zealand) is given as an example from the Southern Hemisphere.

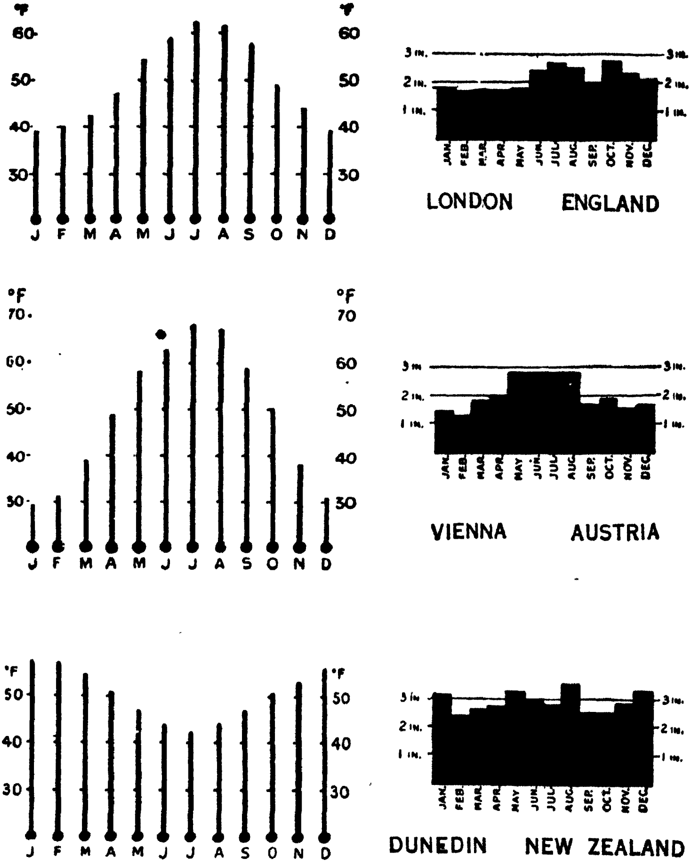


FIG. 48.—The Cool Temperate Oceanic Climate—Temperature and Rainfall Graphs.

COOL TEMPERATE OCEANIC CLIMATE—TEMPERATURE

I. North-West European Type.

Station	Height	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Valencia . .	30	45	*44*	45	48	52	57	59	**59**	57	51	48	45	15·5
Nantes . .	131	*40*	42	45	51	56	62	**63**	65	60	53	45	41	25·6
London . .	18	*39*	40	43	47	53	59	**63**	62	57	49	44	39	24·1
Paris . .	164	*36*	39	43	50	56	62	**65**	64	59	51	43	37	29·0
Hamburg .	82	*32*	33	37	45	53	60	**63**	62	56	48	38	34	31·5

II. Central European Type.

Station	Height	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Berlin . .	164	*31*	32	37	46	55	62	**65**	63	57	48	38	33	34·3
Vienna . .	656	*29*	32	39	49	57	64	**67**	66	59	50	38	31	38·4

III. Others.

Station	Height	Jan.	Feb.	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Victoria . .	85	*40*	42	44	49	54	56	**61**	60	57	52	46	43	20·7
Kamloops .	1193	*25*	28	37	50	58	64	**70**	68	58	48	35	31	45·0
Dunedin . .	500	**58**	57	55	51	47	44	*42*	44	47	51	53	56	15·3

COOL TEMPERATE OCEANIC CLIMATE—RAINFALL

Station	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov.	Dec.	Year
Valencia . .	5·6	4·9	4·1	3·9	3·1	3·5	3·7	5·1	4·6	5·5	5·5	6·5	56·0
Brest . .	3·3	3·0	2·2	2·1	1·9	2·0	2·1	2·1	3·1	3·6	3·8	3·2	32·4
London . .	1·8	1·7	1·7	1·7	1·8	2·3	2·6	2·4	2·0	2·7	2·3	2·1	25·1
Paris . . .	1·4	1·1	1·4	1·5	1·9	2·1	2·0	1·9	1·9	2·1	1·9	1·6	20·8
Hamburg .	1·9	1·7	2·0	1·7	2·2	3·1	3·4	3·0	2·6	2·6	2·3	2·4	28·9
Berlin .	1·5	1·5	1·9	1·4	1·7	2·5	2·7	2·2	1·7	2·0	1·9	1·9	22·9
Vienna . .	1·4	1·3	1·8	2·0	2·8	2·8	2·8	2·8	1·7	1·9	1·6	1·7	24·6
Victoria, B.C.	4·5	3·5	2·5	1·7	1·3	0·9	0·4	0·6	2·0	2·5	6·5	5·9	32·5
Kamloops .	0·9	0·8	0·4	0·3	1·0	1·2	1·2	1·0	1·0	0·5	1·1	0.8	10·2
Dunedin .	3·2	2·3	2·6	2·7	3·4	3·0	2·9	3·5	2·4	2·4	2·9	3·3	34·6

Natural Vegetation.—This climate is the natural home of the Temperate Deciduous Forests. In Monsoon lands the trees lose their leaves to protect them against the heat of the hot season. In the Cool Temperate Deciduous Forests the trees are bare during the winter as a protection against cold. The delicately tissued leaves are easily injured by winter frosts and the trees have made the winter their resting period. The very name of the "fall" of the year, though replaced in England by the less descriptive "autumn," is indicative of the marked nature of the phenomenon of leaf fall. Many of the trees of the Deciduous Forests yield valuable "hardwood" timbers—hard relatively to the softwood timbers of the Coniferous Forests—but more easily worked than the timbers of equatorial lands. Well-known examples are oak, elm, maple, beech, and birch. Deciduous Forests formerly covered most of North-Western and Central Europe, interrupted only by highlands clothed with evergreens or with tracts of moorland and heathland. In North America the admixture of several species of evergreen conifers gives the forests a somewhat different aspect, and the same is true of Tasmania with its evergreen eucalypts.

Development.—The healthy and invigorating nature of the Cool Temperate Climate, necessitating manual work to maintain bodily warmth in winter and escaping unpleasantly high temperatures in summer, favours steady and lasting development of all the regions. Over the greater part of Europe the forests have been cut down to make room for agricultural, pastoral, and industrial development. Except where rainfall is very heavy, wheat, barley, oats, and rye flourish, with maize in the warmer parts; the natural home of the deciduous fruits, such as apples and pears, is here. In drier parts sheep flourish on the hill pastures; in wetter parts the grass grows richly and affords excellent pasture for cattle. The great civilizations of Britain, France, and Germany have been fostered by a climate permitting and encouraging active labour during the whole year. The sometimes regrettable absence of sunshine (London has less than 30 per cent. of the total possible) is countered by the absence of extremes of temperature.

There is still room for further development in Tasmania and New Zealand, whilst Chile's very wet area is still almost untouched.

THE ST. LAWRENCE (LAURENTIAN) TYPE OF CLIMATE

We study next this type of climate because it so closely resembles the last that the two are often taken together. But whereas the Cool Temperate Oceanic Climate occurs on the western margins of the northern continents, and is under the beneficial influence of the Anti-Trade Winds, the St. Lawrence type occurs in corresponding latitudes on the eastern margins of the northern continents. In comparison the winters are much colder—many of the ports, *e.g.* Montreal, are ice-bound; the summers slightly warmer. The most important area is around the Great Lakes and valley of the St. Lawrence in North America, including the Maritime Provinces of Canada and the New England States of U.S.A. The temperature shows a far greater range than is found in corresponding latitudes of the west of the continent. But for reasons which cannot be considered in detail here, the rainfall is remarkably evenly distributed through the year.

In Manchuria and Amuria—including really the North Chinese Plain around Peking—the climate is similar as regards temperature, but the influence of monsoon conditions is seen in the marked summer rainfall maximum. The Japanese Islands have a climate comparable rather to that of North China, but modified by their insular position, and therefore approximating more to a west coast type.

St. Lawrence and Manchurian Types of Climate—Temperature

Station	Height	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
New York .	—	*30*	31	38	48	59	69	**75**	73	66	55	44	34	44·2
Toronto . .	350	23	*21*	30	43	54	65	**69**	67	61	48	37	28	48·0
Halifax . .	88	24	*24*	31	40	49	58	65	**65**	59	49	40	29	40·7
Vladivostok .	50	*5*	12	26	39	49	57	66	**69**	61	49	30	14	64·6
Harbin . .	525	*−2*	5	24	42	56	66	**72**	69	58	40	21	3	73·8
Tokyo . .	69	*37*	38	44	54	61	69	75	**78**	72	61	50	41	40·5

St. Lawrence and Manchurian Types of Climate—Rainfall

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
New York .	3·3	3·3	3·5	3·3	3·5	3·4	4·1	4·4	3·4	3·4	3·6	3·3	42·5
Toronto . .	2·8	2·4	2·1	2·4	2·9	2·6	3·0	2·6	2·8	2·6	2·6	2·6	31·4
Halifax . .	6·0	4·7	5·1	4·6	3·8	3·8	3·7	4·6	4·1	5·5	5·9	5·5	57·3
Vladivostok .	0·1	0·2	0·3	1·2	1·3	1·5	2·2	3·5	2·4	1·6	0·5	0·2	14·7
Mukden . .	0·2	0·2	0·6	1·0	2·4	3·2	6·7	4·3	2·6	1·7	0·5	0·2	23·5
Tokyo . .	2·0	2·6	4·3	5·3	5·9	6·3	5·6	4·6	7·5	7·2	4·3	2·3	57·9

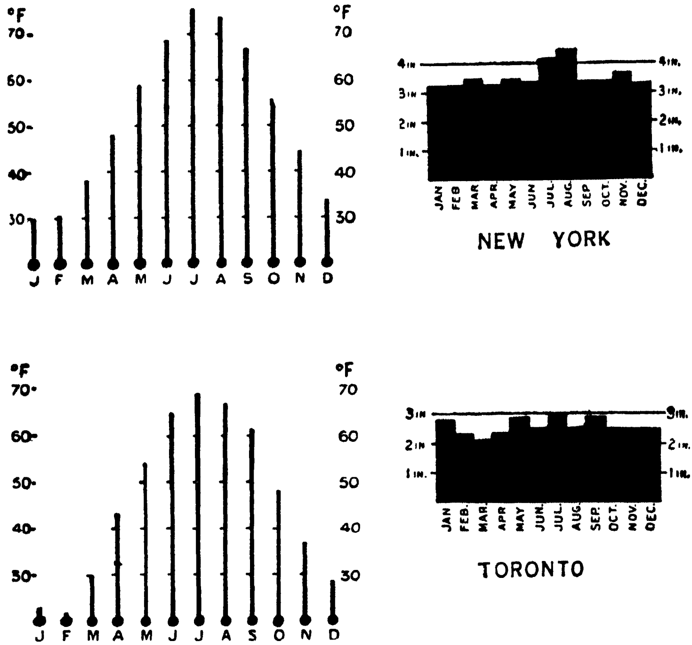


Fig. 49.—The St. Lawrence Type of Climate—Temperature and Rainfall Graphs.

Natural Vegetation.—The forests which normally clothe the areas now under consideration do not differ greatly from the Deciduous Forests of North-West Europe. There is usually, however, a more marked admixture of softwood conifers.

Development.—It is superfluous to point out the similarity in development between the north-eastern U.S.A. and the north-west of Europe. Though the winter cold in the former may be more trying than the milder winters of the latter, the difference has not materially affected industrial development. Both have been termed "Regions of Effort," where man is rewarded in proportion to the effort expended. Japan affords a fine example of recent development, and Manchuria shows signs of following suit.

It is convenient to notice here the remarkable concentration of industrial enterprise and the population which results therefrom in the cool temperate regions both east and west of the continents. In consequence of the vast population the regions are no longer self-supporting and require to supplement their home supplies of foodstuffs by large imports from agricultural regions. Britain, New England, Germany, and Japan are all in this position.

THE TEMPERATE CONTINENTAL CLIMATE[1]

This type of climate is characteristic of the interiors of the great land masses, lying in the same latitudes, approximately, as the North-West European and St. Lawrence types, but removed from the influence of the sea. The extremes of temperature are greater, the total rainfall less. The two typical areas are the Prairies of North America—hence the name, "Prairie Type"—and the Steppes of Eur-Asia. The light spring and summer rains encourage the growth of grass but are insufficient for trees, hence the alternative name, "Temperate Grassland Climate." The winters are long and severe; the summers short but warm.

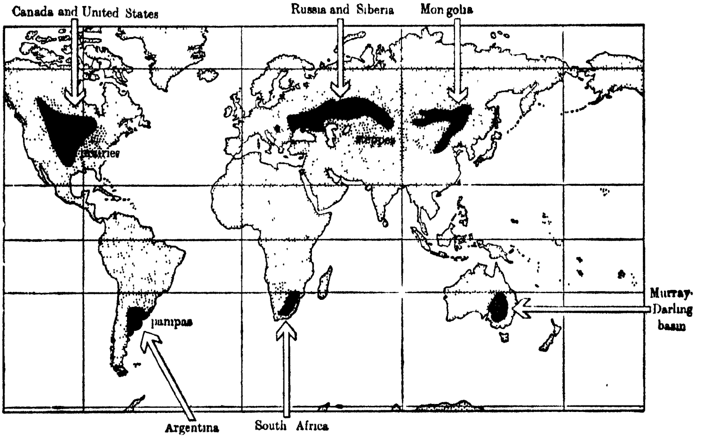


FIG. 50.—The Temperate or Mid-Latitude Continental Climate. Map showing the distribution of the Temperate or Mid-Latitude Grasslands.

Temperature.—When considering the climate of North-Western and Central Europe the marked increase in range of temperature, experienced as one travels eastwards, was specially noted. The range becomes still greater in Eastern Europe and Western Asia. The same is true of the Prairies of North America, with a greater range of temperature than either the west or the east coast.

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[1] Because of the great extremes of temperature this climate is perhaps better called the "Mid-Latitude Grassland Climate."

Odessa may be taken as typical of the southern and warmer parts of the European Steppes, Barnaul of the Asiatic Steppes, and Winnipeg of the Canadian Prairies.

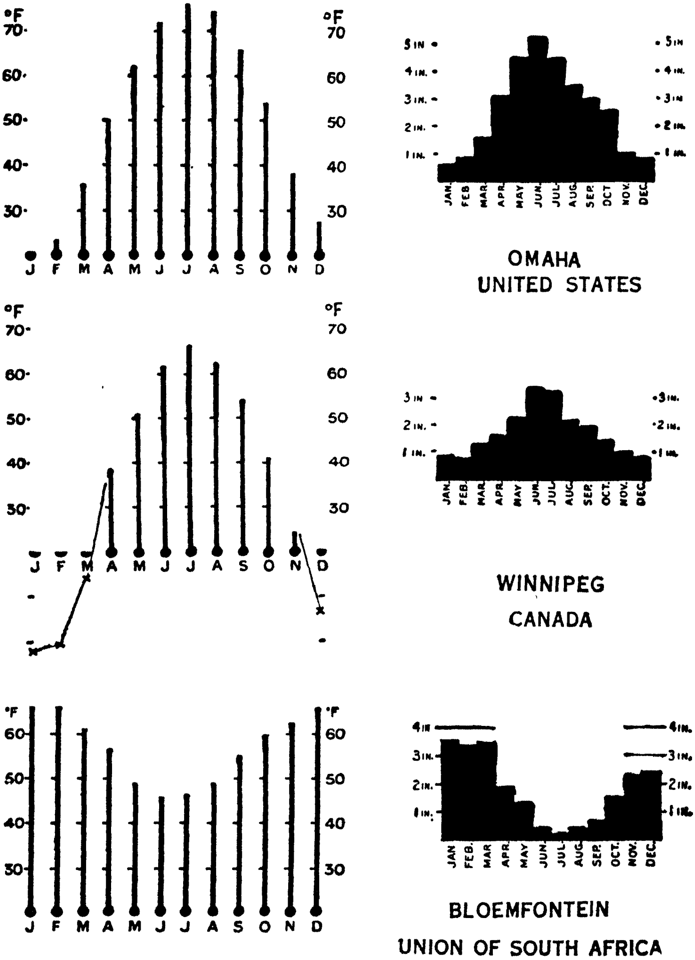

Fig. 51.—The Temperate Continental Climate—Temperature and Rainfall Graphs.

In the Southern Hemisphere the land masses are so much narrower that the extreme continental type does not occur. In South America, however, the Pampas, cut off by the high Andes from the Anti-Trade Winds of the South Pacific, enjoy a comparable though more moderate climate. In South Africa temperate grassland is found on the surface of the lofty South African Plateau. Here temperatures are much higher, snow being a great rarity, and the existence of the grasslands is largely due to elevation. The Murray-Darling Basin in Australia has also a greatly modified continental climate. Bahia Blanca, Bloemfontein,[1] and Bourke have been taken as typical of these southern grasslands. Those grasslands which occur in latitudes comparable with the warm temperate regions of the coasts are sometimes separated as the Turan type. The Turan type would include the Southern Prairies of U.S.A. and the grasslands of the Murray-Darling Basin in Australia.

Rainfall.—The rainfall in typical regions ranges between 10 and 30 inches. The light spring showers are ideal for the germination of grasses, the growth of which is assisted by the early summer rains. The great heat of late summer and the intense cold of winter are alike immaterial; the grass seeds and withers. In the cold regions of the Northern Hemisphere the winter precipitation is, of course, in the form of snow. It is to be noted that the melting of the winter snows there enhances the supply of moisture in spring

TEMPERATE CONTINENTAL CLIMATE—TEMPERATURE

Station	Height	Jan.	Feb	Mar	April	May	June	July	Aug	Sept	Oct.	Nov	Dec.	Range
Winnipeg	1,492	*−3*	−1	15	39	51	62	**66**	63	54	41	24	7	68·5
Omaha	1,103	*20*	24	36	50	62	72	**76**	74	66	54	38	27	56·0
Odessa	210	*25*	28	35	47	59	68	**73**	71	62	52	41	31	47·4
Barnaul	480	*−2*	1	13	33	51	62	**67**	62	50	35	16	4	69·3
Bahia Blanca	49	**71**	70	66	59	52	46	*45*	47	53	57	63	67	25·2
Harrismith	5,320	65	65	61	56	49	*46*	46	49	55	60	63	65	19·7
Bourke	460	**84**	83	77	68	58	54	*51*	56	63	70	76	82	32·8

TEMPERATE CONTINENTAL CLIMATE—RAINFALL

Station	Jan	Feb	Mar	April	May	June	July	Aug.	Sept	Oct	Nov.	Dec.	Year
Winnipeg	0·9	0·8	1·3	1·6	2·2	3·3	3·2	2·2	1·9	1·4	1·0	0·9	20·9
Omaha	0·6	0·8	1·4	3·0	4·4	5·2	4·4	3·4	3·0	2·5	1·0	0·9	30·4
Odessa	0·9	0·7	1·1	1·1	1·3	2·3	2·1	1·2	1·4	1·1	1·6	1·3	16·1
Barnaul	0·3	0·2	0·3	0·4	1·0	1·4	1·8	1·6	0·9	0·9	0·7	0·6	10·1
Bahia Blanca	1·7	2·1	2·7	2·1	1·2	1·1	1·0	1·1	1·5	2·2	2·2	1·9	20·8
Bloemfontein	3·6	3·4	3·5	1·9	1·3	0·4	0·2	0·4	0·7	1·6	2·3	2·4	21·7
Bourke	2·0	1·9	1·6	1·4	1·1	1·0	0·9	0·9	1·0	1·1	1·3	1·1	15·2

Natural Vegetation.—The Temperate Grasslands form a type of natural vegetation as distinctive in its own way as the Equatorial Forests. The grass is typically lower but less coarse than in the Tropical Grasslands, but the feature which strikes the eye is the absolute treelessness of the rolling plains. The contrasts between the tender green of the spring, the brown dried-up wastes of late summer and the boundless sheet of snow in winter are characteristic again of the Northern Hemisphere. The grasslands of the Argentine and South Africa agree in the treelessness, but in Australia there are comparatively small tracts without a few scattered eucalypts, either as trees or bushes. In the Southern Hemisphere snow is rare in South Africa or Australia.

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[1] Or Harrismith, of which more accurate temperature figures exist, and which is closely comparable.

As in the Tropical Grasslands the native animals fall into two classes:

(*a*) The herbivores, or grass eaters, usually swift of foot and, in many cases, able to take a hurried meal to be chewed again in quiet.

(*b*) The carnivores, preying on the grass-eating animals of the first class.

The wild horse and the wild ass are typical members of the first class, and experiments have shown that the wild ass is capable of maintaining a speed of forty miles an hour for ten or a dozen miles.

Development.—Primitive man, as a native of the grasslands, may be classed primarily with the second group of animals. As were the Red Indians of the Prairies, he is primarily a hunter. The second stage in human development comes with the domestication of such animals as the sheep, goat, ox, and horse. Pastoral industries become of prime importance. At this stage man is essentially nomadic, wandering about with his flocks and herds in search of fresh pasture. Droughts, and a consequent shortage of pasture, have repeatedly led, throughout history, to great movements of these nomadic peoples and raids on the settled populations of surrounding lands. It is interesting to note that the rearing of sheep is still the first industry on the Grasslands of South Africa, Australia, and parts of the Argentine. In Canada the extremes of cold are too severe. But a climate so favourable for the growth of native grasses has naturally proved equally favourable to those grasses which man has helped to perfect as the main cereals. The Temperate Grasslands have become the world's granaries from which the deficiencies of the industrial countries are supplied. Except in South Africa, where maize leads, wheat is the crop of first importance in international commerce, followed by barley, oats, and rye. The Prairies, the Pampas, the Veld of South Africa, and the Grassland of Australia are already well tilled; there are still areas to be developed in Asiatic Russia. The one great area still largely undeveloped is in Mongolia and Manchuria. Even here Chinese settlement is going on rapidly.

THE TEMPERATE DESERT CLIMATE

Although it occurs for the most part nearer the equator than the types just studied, the Temperate Desert Climate has been left for consideration until now because it is closely related to four of the preceding types. This relationship is brought out in the diagram, Fig. 35. The Temperate Deserts are almost restricted to the heart of the great land mass of Eur-Asia, where they occupy a central position. Inland the Hot Deserts, the Mediterranean lands, the Temperate Grassland, the St. Lawrence regional type, and the China type all fade into the central mass of Temperate Desert. In North America the enclosed plateaux of the Rocky Mountain System belong to the same type.

The Temperate Deserts occupy plateaux, cut off from the oceans by distance and mountain barriers. They agree in having wide ranges of temperature and a very low rainfall. Generally they form huge areas of high pressure—great masses of cold air—in winter, and areas of low pressure with inblowing winds in summer. The scanty rainfall is therefore mainly in summer, except in those regions like Persia, which border the Mediterranean countries.

Varying elevation and latitude permit of a subdivision of the Temperate Deserts into at least two types:

(*a*) The Tibet type—including the high plateaux of Tibet in Asia (over 11,000 feet) and of Bolivia in South America (over 11,000 feet). The Bolivian plateau is, however, rather well watered to be called a desert, or even semi-desert, region, and is closely akin to the Ecuador type already discussed.

(*b*) The Iran type—including the Gobi Desert region, the enclosed plateau of Persia, the enclosed plateaux of North America around Salt Lake City—at a lower elevation than the last. Some depressions—for example, the Tarim Basin—may descend even below sea level. The Turan Basin—Russian Turkistan—gives its name to yet another type, at or near sea level.

The driest types of Temperate Grassland, though not necessarily lying in enclosed plateaux, belong to the general group of the Temperate Deserts. It should be noted that some authors include under the Iran type those plateau regions like the High Veld of South Africa, which by virtue of a higher rainfall are grasslands and not deserts or semi-deserts.

Temperature.—The rarity of the atmosphere at high levels results in some extraordinary freak phenomena of temperature. In Tibet the ground temperature in the sun may be over 130°, whilst it is freezing in the shade. There are similarly enormous differences between day and night temperatures. Some of the greatest known annual ranges are in the climates of the Temperate Deserts. Because of the extremes the climate is better called "Mid-Latitude Desert."

Rainfall.—The rainfall varies from 15 inches downwards. Semi-desert conditions may prevail where the rainfall is rather more. In the higher regions some of the precipitation is in the form of snow.

THE TEMPERATE DESERT CLIMATE—TEMPERATURE

Station	Height	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Range
Kashgar (Central Asia) .	4,255	*22*	34	46	61	70	77	**80**	76	69	55	40	26	57·9
Urga (Gobi Desert) .	3,800	*–15*	–4	13	34	47	59	**63**	59	47	29	8	–7	78·7
Lukchun (Tarim Basin)	–50	*13*	27	45	66	75	85	**90**	85	74	55	33	21	77·3
Leh (Kashmir)	11,503	*17*	19	31	43	50	58	**63**	61	54	43	32	22	45·3
Teheran (Persia) .	4,002	*34*	42	48	61	71	80	**85**	83	77	66	51	42	51·3
Salt Lake City	4,366	*29*	33	41	50	57	67	**75**	74	64	52	41	32	46·5
La Paz (Bolivia) . .	12,100	52	51	51	49	47	**44**	45	46	48	50	**53**	52	8·6

Note the similarity between La Paz and Quito (p. 39).

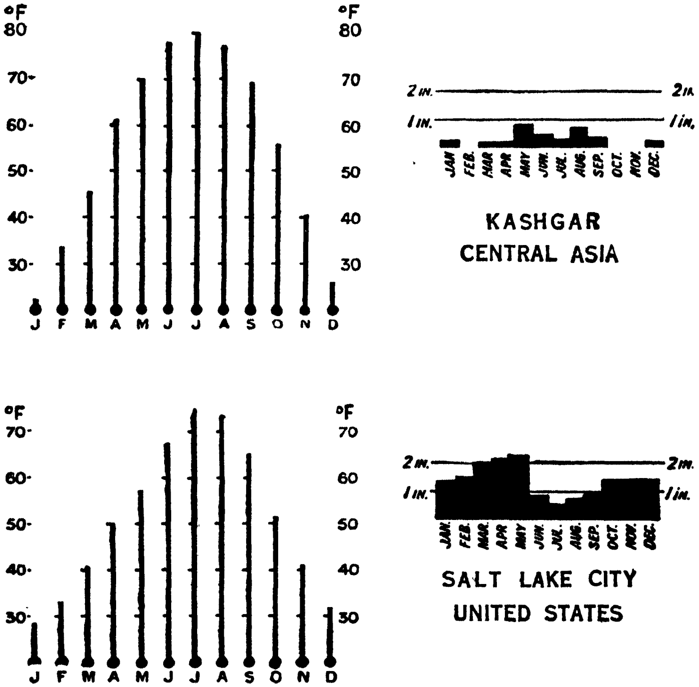

FIG. 52.—The Temperate Desert Climate—Temperature and Rainfall Graphs.

THE TEMPERATE DESERT CLIMATE—RAINFALL

Station	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Kashgar . .	0·3	0	0·2	0·2	0·8	0·4	0·3	0·7	0·3	0	0	0·2	3·5
Leh . . .	0·3	0·4	0·2	0·2	0·3	0·2	0·5	0·5	0·2	0·2	0	0·2	3·2
Teheran . .	1·2	0·9	2·4	0·9	0·4	0	0·4	0	0·1	0·1	1·2	1·3	8·9
Salt Lake City	1·3	1·5	2·0	2·1	2·2	0·8	0·5	0·8	0·9	1·4	1·4	1·4	16·3
La Paz . .	3·9	4·5	2·6	1·5	0·5	0·1	0·2	1·1	0·8	1·3	1·5	4·3	21·2

Natural Vegetation.—It is difficult to give any general account of the vegetation of the varied regions under consideration. Often there is a close affinity with neighbouring, more fertile regions. Thus some of the Temperate Deserts are very, very poor grasslands and pass outwards into the normal grassy steppes. Other tracts represent the driest tracts of Mediterranean lands. Some areas, such as the Tibetan Plateau, have a vegetation specialized by reason of elevation; others, especially the larger depressions, are of the nature of complex oases.

Development.—Except in a few spots where minerals have been the source of attraction the Temperate Deserts are very thinly inhabited. They have been termed "Regions of Lasting Difficulty." In Asia several ancient land routes run right across the interior plateaux from east to west, and a feature of great interest is the numerous ruins of ancient settlements and cities which seem to prove that the interior of Asia was once more fertile than it is now.

THE COLD TEMPERATE CLIMATE

Stretching as a broad belt right across the Northern Hemisphere is a region whose average temperature is low and where the greater part of the somewhat scanty precipitation is in the form of snow. The natural vegetation is everywhere of the evergreen coniferous forest type; the warm of the summer sun is insufficient for the ripening of cereals. A feature of very great significance is the enormous difference between the length of the very short winter

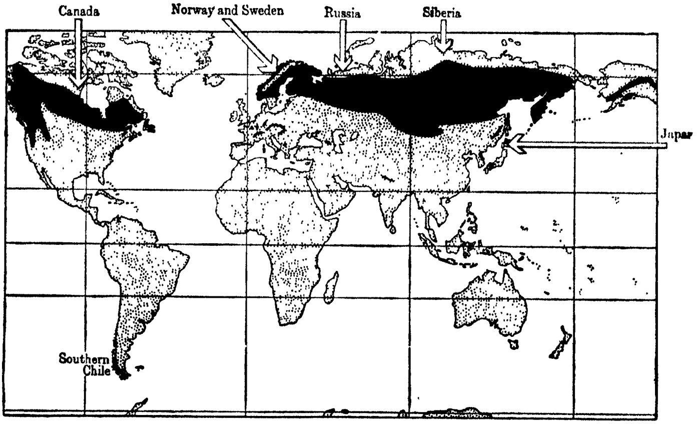

FIG. 53.—Map showing the distribution of the Coniferous Forests or Taïga, which corresponds closely, but not exactly, with that of the cold temperate climate. The principal exception is in British Columbia and North-Eastern U.S.A., where coniferous forests occur with a North-West European type of climate.

days and the very long summer days. In certain tracts near the ocean the range of temperature between summer and winter may be comparatively small, but in the heart of Northern Asia there are tracts with a range of over 100°—the greatest in the world.

In the Southern Hemisphere only the extreme south of South America and the mountains of New Zealand have a climate sufficiently cold to belong to this type.

Temperature.—Nearly all stations have an average temperature for the year below 40° and over very large areas the average is below freezing. There is usually a short but surprisingly warm summer, with the average for the hottest month approaching 70°. Three months with a temperature of over 60° are needed for the ripening of wheat; in this type of climate only the southern margins are sufficiently warm, although the long summer days permit the hardier grains to ripen with remarkable rapidity. In Europe, Trondhjem is a maritime station in Norway; Hernösand lies in the same latitude in Sweden; Leningrad lies on the southern borders of the belt, Archangel on the northern borders. Verkhoyansk shows the most extreme type of Northern Asia. In North

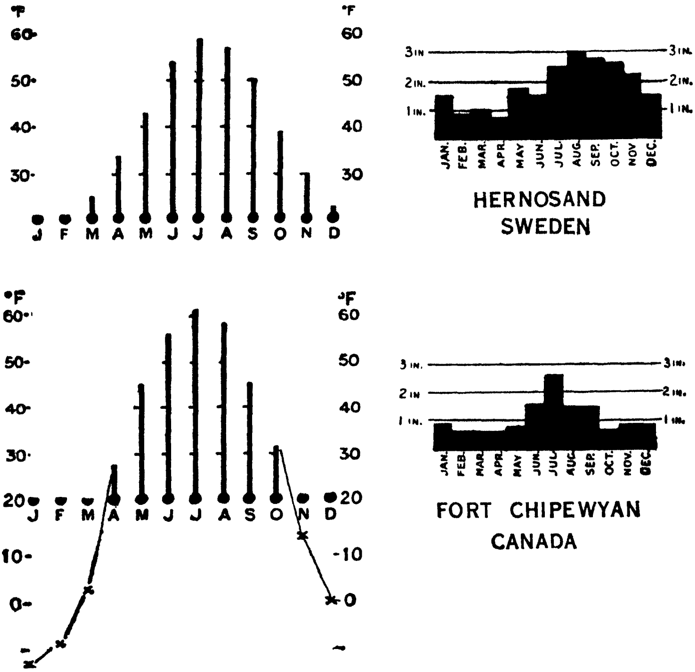

FIG. 54.—The Cold Temperate Climate—Temperature and Rainfall Graphs.

America, Ottawa lies on the southern margin of the belt, Fort Chipewyan in the heart of the continent.

Rainfall.—Except in regions influenced by the nearness of the sea (*e.g.* Norway) and the more favoured southern margins, the rainfall rarely exceeds 20 inches in total amount. Much of this falls as snow and lies on the ground during the winter, so that when the warmth of spring comes it melts and soaks gently into the ground. The ground, therefore, gains the full benefit; further, owing to the low temperature evaporation is slight. A rainfall as low as 10 inches is thus adequate for tree growth. Most areas show a marked summer maximum in rainfall.

Cold Temperate Climate—Temperature

Station	Height	Jan.	Feb	Mar	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Avge.	Range
Trondhjem .	33	27	*27*	30	38	46	53	**57**	56	50	41	33	27	40	30·4
Hernösand .	344	20	*20*	25	34	43	54	**59**	57	50	39	30	22	38	39·3
Leningrad .	30	*15*	17	23	36	48	59	**64**	61	51	40	29	20	39	48·6
Archangel .	50	*7*	9	18	30	41	54	**60**	57	47	34	22	11	32	53·1
Verkhoyansk	330	−*59*	−47	−24	7	35	54	**60**	50	36	5	−34	−53	3	118·6
Ottawa . .	294	*12*	14	26	43	56	65	**70**	67	59	47	32	17	43	57·7
Fort Chipewyan .	699	−*13*	−9	4	28	45	56	**62**	58	45	32	14	0	28	75·1

Cold Temperate Climate—Rainfall

Station	Jan.	Feb	Mar.	April	May	June	July	Aug.	Sept	Oct.	Nov.	Dec.	Year
Trondhjem .	3·3	2·3	2·5	2·2	2·3	2·5	2·6	2·6	3·3	4·3	3·5	4·3	35·7
Hernosand .	1·5	0·9	1·0	0·8	1·7	1·5	2·5	3·0	2·8	2·6	2·2	1·6	22·1
Leningrad .	0·9	0·8	0·9	0·9	1·7	1·8	2·7	2·7	2·0	1·7	1·4	1·2	18·8
Archangel .	0·8	0·7	0·8	0·7	1·0	1·5	2·2	2·1	2·0	1·5	1·1	0·8	15·3
Verkhoyansk	0·2	0·1	0	0·1	0·2	0·5	1·2	0·9	0·2	0·2	0·2	0·2	3·9
Ottawa . .	3·0	2·6	2·6	1·9	2·7	3·5	4·0	2·1	2·6	2·3	2·5	2·7	32·5
Fort Chipewyan . .	0·9	0·6	0·6	0·6	0·8	1·6	2·6	1·6	1·6	0·8	0·9	0·9	13·5

Natural Vegetation.—Northwards both the Deciduous Forests and Temperate Grasslands give place to the Coniferous Forests or Taïga. The peculiar structure of the thick-skinned resinous leaves affords adequate protection both against cold and excessive transpiration, and the majority of the trees are evergreen. The finest tree growth is in the wetter, warmer parts, northwards the trees become scattered and smaller, giving place eventually to the barren wastes of the tundra. The Coniferous Forests are the world's great storehouse of soft timber—such as deal cut from fir trees. The great belt of forest stretching across North America is the most important in the world; in Europe there are the forests of Scandinavia and Northern Russia, whilst the same type reappears on the hills and mountains of North-Western and Central Europe. Across the north of Asia the forested areas are largely inaccessible and suffer from the peculiar physical conditions of the land. The great rivers there flow northwards towards the frozen Arctic Ocean and are themselves frozen throughout the winter. In the spring the

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[1] Some of the deciduous trees are valuable, *e.g.* birch for plywood.

upper courses in the warm south melt, whilst the central and lower courses are still icebound; with the result that flood-waters spread far and wide over the flat country, and turn the taïga into a vast forested morass. This state of affairs is reflected in the rotten condition of much of the timber.

The animals of the northern forests are protected from the cold by thick fur.

Development.—The sparsely inhabited Coniferous Forests are occupied mainly, before development, by hunters and trappers, who obtain meat and clothing, and most of the necessities of life, from the wild animals. In the economy of a civilized world logging and timber-working industries take first place, the production of wood pulp for paper being not the least important of the uses of coniferous wood. The trees are felled during the winter, dragged over the slippery snow to the watercourses and floated down the rivers when the snows melt. Accessibility, the presence of streams suitable for floating, and the existence of water-power for saw-mills and pulping mills are the factors influencing development. By far the most important areas are along the southern fringes of the forest in Eastern Canada, and in the countries of Northern Europe. Agriculture is only possible in clearings along the southern fringes of the forests (compare the temperatures of Ottawa, permitting of the ripening of grain).

The influence of the abundance of easily worked wood is seen in the dwellings in forested regions—ranging from the rough log cabins of the Canadian backwoodsman to the elaborate chalets of the Swiss mountain forests. The great danger of fire in these resinous soft-wooded forests should be noted.

THE TUNDRA OR COLD DESERT CLIMATE

Within the Arctic Circle the winters are very long and very cold—there are at least some days on which the sun never appears—and the summers very short and sharp. Though for certain periods the sun never sets, it never rises far above the horizon. Temperature and rainfall are comparable with those in the northern parts f the coniferous forests, but summer temperatures are lower. The atural vegetation is moss and lichen, with stunted bushes and trees near the forest limit. Agriculture is impossible, for the ground is frozen for three-quarters of the year. The few poor inhabitants live mainly on fish—often caught through holes in the ice—or depend for food and clothing on the reindeer or caribou. Schemes for the economic development of these dreary "Barren Lands," which occupy vast areas in Northern Canada, depend upon the breeding of the reindeer or caribou. Economic development may be rendered possible also by the sometimes surprisingly rich growth of grass and flowering herbs which is the result of the warm, if very short, summer. These grassy areas have been called "Arctic prairies."

The conditions found in the Antarctic Continent or Greenland, with their great permanent ice caps, represent the ultimate development of the extreme type of cold desert climate.

Before terminating this chapter reference must once more be made to the paramount importance of elevation in determining local variations. In a very broad way one passes through the same vegetation zones when ascending a mountain in the tropics as one does in journeying from the tropics polewards. The importance of stretches of "Alpine" pasture or of mountain soft-wood forests, occurring as the natural result, is very great in the economic development of a country. Switzerland and Germany are examples worthy of close study in this respect.

EXERCISES

1. Rainfall figures have been expressed in this chapter by a certain type of graph. Take a set of figures from each type of climate and draw graphs of a different kind.

2. Take a characteristic set of temperature figures from each type of climate and turn them into centigrade.

3. Take a characteristic set of rainfall figures from each type of climate and turn them into millimetres.

4. On a map of the world mark distinctly (*a*) those regions with summer rainfall, (*b*) those regions with a winter rainfall, (*c*) those regions with the rainfall distributed throughout the year.

5 Identify accurately the position of all stations mentioned in the tables in this chapter, and mark them on a map of the world.

EXAMINATION QUESTIONS

1. Construct graphs to represent the following data for mean monthly temperature and monthly rainfall at a particular station, and add short notes on the probable position of the station, the essential features of its climate, and the most likely crops grown in the neighbourhood:

Temperature (Degrees Fahrenheit)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
63·0	63·0	60·5	57·4	55·1	53·3	52·8	52·8	54·1	57·1	59·3	62·7

Rainfall (Inches)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0·0	0·0	1·0	0·2	3·0	4·0	2·9	1·6	0·8	0·4	0·2	0·0

(*Univ. Oxford Cert.*, 1926.)

2. The following table states the mean monthly temperature (*t*) in degrees Fahrenheit, and the mean monthly precipitation (*r*) in inches of rain of a station X which is near sea-level. Express these data in the form of graphs, and from them give a precise account of the climate of X. In what type of region is X situated?

	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
t	78·6	78·4	78·8	79·3	78·8	78·8	79·3	80·6	81·1	81·1	80·6	79·2
r	14 1	12·1	15·2	15·5	20·0	14·8	6·5	2·6	1·1	1·3	4·6	10·6

(*Univ. Leeds Inter.*, **1926.**)

3. The following figures state mean monthly climatic data for a coastal station "S." Draw graphs to show the march of temperature and rainfall throughout the year at S., describe the climate as fully as you can, and state the type of major natural region in which S. is situated.

	Jan.	Feb	Mar.	April	May	June	July	Aug	Sept	Oct.	Nov.	Dec.
t (in °F.) .	82·0	82·9	83·6	83·8	83·6	82·0	80·2	79·7	79·5	80·6	81·4	81·8
pp^n (in inches of rain) .	0·5	0·4	0·8	5·5	13·4	21·2	36·9	35·0	32·4	14·1	5·1	1·0

(*Univ. Leeds*, 1*st Year*, 1927.)

4. The climatic data given below refer to three stations, at altitudes of less than 1,000 feet, in three important agricultural regions.

		Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov.	Dec
A	°F. .	75	77	81	85	82	79	79	79	79	80	78	76
	Ins. .	0·1	0·2	0·2	1·7	11·7	18·3	21·4	19·6	15·9	7·1	2·5	0·1
B	°F.	−3	−1	15	39	51	62	66	63	54	41	25	7
	Ins. .	0·9	0·8	1·3	1·6	2·2	3·3	3·2	2·2	1·9	1·4	1·0	0·9
C	°F. .	74	74	71	66	60	56	54	56	58	61	65	71
	Ins. .	0·3	0·3	0·7	1·7	4·9	6·6	6·4	5·6	3·3	2·1	0·8	0·6

Suggest possible localities and staple crops for each of the places, giving reasons. (*Univ. London Inter B. Com.*, 1927.)

5. Compare the climate of Winnipeg with that of Vancouver. To what class of climate does each belong? (*Univ. British Columbia Sessional*, 1927.)

6. Describe a tropical hurricane. In what parts of the world, at what season, and under what other name are such storms known? (*Univ. British Columbia Sessional*, 1927.)

7. *Either*, Give some account of the leading geographical factors that determine the nature of vegetation.

Or, Under what physical conditions does steppe occur? Give an account of the main economic products of some steppe region. (*Univ. Oxford Cert.*, 1926.)

8. Describe and explain the normal temperature and rainfall régime of the following: Peking, Bombay, Singapore, and Winnipeg. If possible, illustrate your answer by temperature and rainfall graphs. (*Univ. Bristol Inter.*, 1924.)

9. The following figures state the mean monthly temperatures and rainfall of a station *A*. Express these facts in the form of graphs (on the squared paper). Give as full an account as you can of the climate of *A* and discuss its position on the globe.

Temperatures (Degrees Fahrenheit)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
63	63	60·5	57·4	55·1	53·3	52·8	52·8	54·1	57·1	59·3	62·7

Rainfall (Inches)

0·0	0·0	1·0	0·2	3·0	4·2	2·9	1·6	0·8	0·4	0·2	0·0

(*Univ. Bristol Inter.*, 1926.)

10. What contrasts in type of cultivation occur in regions where (*a*) rain and heat are coincident, followed by a long dry season, (*b*) a cool rainy season is followed by heat and drought?

Your answer should refer to actual examples. (*Univ. Bristol Inter.*, 1926.)

11. Describe the different types of climate met in temperate latitudes giving details of the relations between each climatic type and the controlling earth features. (*Univ. British Columbia Sessional*, 1927)

12. Discuss the problem of the agricultural development of equatorial regions (*Univ. London B.A. Hons. Econ. Geog.*, 1927.)

13. Describe the characteristic climatic conditions of the Cool Temperature West Margin type of Major Natural Region; and show how they are related to its location. (*Univ. Leeds*, 1*st Year*, 1927.)

14. Describe and explain the normal temperature and rainfall régime of any place experiencing typically monsoon climate. If possible illustrate your answer by temperature and rainfall graphs. (*Univ. Bristol Inter.*, 1925.)

15. What do you understand by the term savanna? Describe and account for the distribution of savanna in Africa. (*Univ. Sheffield Inter. Hons.*, 1925.)

16. Give an explanatory account of the climates and vegetation of the tropical grasslands of the Southern Hemisphere, with clear indication of their approximate limits. (*Univ. London Inter. B. Com.*, 1927.)

17. Locate, classify, and account for the chief areas of natural grassland in the world. (*Univ. Bristol Inter.*, 1925.)

18. Describe and locate the different types of grassland in the world, explaining the geographical factors to which all grassland is due. (*Univ. Bristol Inter.*, 1927.)

19. Discuss the significance of the grasslands of the southern hemisphere, in their relation to successive phases of human occupation. (*Univ. Bristol Inter.*, 1926.)

20. What do you understand by temperate grasslands? Mention the more important types and consider the climatic environment of each. (*Univ. Sheffield Inter.*, 1926.)

21. What climatic factors are favourable or unfavourable to the growth of grasslands? Explain fully the reasons. (*Univ. Sheffield Inter. Hons.*, 1927.)

22. Discuss the characteristics of climate and natural vegetation that are common to temperate grasslands, and estimate the economic value of these lands to-day. (*Univ. Oxford Cert.*, 1926.)

23. Give figures of temperature and rainfall for a typical Mediterranean climate, and write a description of the climate of the lands bordering the Mediterranean Sea, noticing deviations from the typical. (*Univ. London Inter. B. Com.*, 1927.)

24. Give an account of the characteristic features of the Mediterranean type of climate. Discuss the relation of these features to the location of the regions in which this type of climate occurs. (*Univ. Leeds Inter.*, 1926.)

25. Describe the general distribution of Forest and Grassland regions in *either* North America *or* Africa, and discuss the relation of these regions to climatic factors. (*Univ. Leeds Inter.*, 1926.)

26. Describe and explain the seasonal changes of pressure, temperature, and rainfall in the Cool Temperate Zone of the Northern Hemisphere. (*Univ. Bristol Inter.*, 1925.)

27. Give a broad classification on a climatic basis of the regions of the world which have very low rainfall, discussing the distribution of the chief classes named in connection with the main facts of atmospheric circulation. (*Univ. Bristol Inter.*, 1926.)

28. Give reasons for the positions of the deserts on the surface of the earth. (*Univ. British Columbia Sessional*, 1926.)

29. Explain the distribution of hot deserts upon the globe by reference to the climatic factors involved. (*Univ. Sheffield Inter.*, 1925.)

30. Give a brief geographical account of the distribution and characteristic features of the Northerly Cool Temperate Coniferous Forests. Mention their chief economic products. (*Univ. Bristol Inter.*, 1925.)

31. Give an account of the character and climatic conditions of coniferous forests. (*Univ. Oxford Cert.*, 1927.)

32. Write a brief account of the climate of *either* the Temperate Grasslands *or* the Equatorial Forests and indicate where the climate you describe is found. (*Univ. Rangoon Inter.*, 1926.)

33. Certain parts of the world have rain in winter but very little or no rain in summer. Name these parts of the world, and explain fully why their rainfall is thus distributed.

34. Certain coasts in the world are deserts. Name them, and taking each one separately explain why desert conditions prevail. (*Univ. Rangoon Inter.*, 1926.)

35. "In Monsoon lands the areas of densest population and heaviest rainfall frequently coincide." Show with the aid of sketch-maps how far this is true of India, and why. (*Univ. Rangoon Inter.*, 1926.)

36. Describe the natural productions of the equatorial forests and give an account of their commercial exploitation (*Govt. Burma High School*, 1925.)

37. Describe the climates of the Pacific coast lands of South America (*Univ. London Inter. B. Com.*, 1924.)

38. Illustrate shortly from the British Empire the main types of climate. (*Univ. London Inter. B. Com.*, 1921.)

39. Describe carefully the tropical monsoon type of climate. (*Univ. London Inter. B. Com.*, 1929.)

40. In what ways do "east coast" climates differ from their counterparts on the western borders of the great land masses in the northern hemisphere? Explain and give examples. (*Univ. London Inter. B. Com.*, 1930.)

41. Describe carefully the climate found in tundra regions and outline any economic development of these lands you consider possible. (*Univ. London Inter. B. Com.*, 1930.)

42. What are the chief characteristics of the climate of Mediterranean lands? How do these conditions affect the natural vegetation and crops? (*Univ. London Inter. B.Sc. Econ.*, 1930.)

43. The following climatic data are of places in India. In each case suggest a possible locality and give a brief description of the climate of the place.

		J.	F.	M.	A.	M.	J.	J.	A	S.	O.	N.	D.
A	Ppt.	1·5	1·3	1·9	1·8	0·7	0·3	1·7	2·2	0·7	0·2	0·6	0·5
	T.°F.	49·7	53·3	63·3	73·5	84·0	91·2	90·3	87·6	82·1	71·4	59·1	51·1
B	Ppt.	0·3	1·0	1·1	1·5	5·6	11·0	12·3	12·7	10·4	3·9	0·6	0·3
	T.°F.	65·2	70·3	79·3	85·0	85·7	84·5	83·0	82·4	82·6	80·0	72·4	65·3
C	Ppt.	0·8	0·3	0·4	0·6	2·0	2·1	3·8	4·7	4·8	10·9	13·3	5·3
	T.°F.	75·3	76·6	79·5	84·1	88·7	88·4	85·7	84·5	83·9	80·8	77·9	75·7
D	Ppt.	0·8	0·5	0·4	0·1	0·3	5·1	12·2	10·9	6·3	2·4	0·2	0·2
	T.°F.	59·5	64·9	76·8	87·6	92·5	90·8	84·5	83·2	83·0	77·6	67·5	59·8

(*Univ. London Inter. B.Sc. Econ.*, 1929.)

44. The stations A, B, C, and D, for which the average monthly rainfall and the mean monthly temperatures are given below, are all situated approximately at sea level. For each station—

(*a*) Draw temperature and rainfall graphs.

(*b*) Calculate the temperature range.

(*c*) Deduce, giving reasons in full, the type of climate and consequent natural vegetation and mention possible areas or locations.

														Year
A	Rainfall (ins.) .	0	0	0	0·1	0·5	20·6	24·6	14·9	10·9	1·8	0·5	0·1	74·0
	Temp. (° F.) .	75	75	78	82	85	82	80	79	79	81	79	76	
B	Rainfall (ins.) .	0·9	0·7	1·1	1·1	1·3	2·3	2·1	1·2	1·4	1·1	1·6	1·3	16·1
	Temp. (° F.) .	25	28	35	47	59	68	73	71	62	52	41	31	
C	Rainfall (ins.) .	3·2	2·3	2·6	2·7	3·4	3·0	2·9	3·5	2·4	2·4	2·9	3·3	34·6
	Temp. (° F.) .	58	57	55	51	47	44	42	44	47	51	53	56	
D	Rainfall (ins.) .	3·8	2·9	3·0	1·6	0·8	0·1	0	0	0·2	0·9	2·1	4·0	19·4
	Temp. (° F.) .	45	50	54	58	63	69	72	72	69	62	53	46	

(*Univ. London Higher Schools B & D*, 1932.)

CHAPTER V

THE DISTRIBUTION AND ACTIVITIES OF MAN

FACTORS GOVERNING DISTRIBUTION

IN the last chapter we have seen that the distribution of natural vegetation in the world is controlled by the environmental factors of climate and topography. Topography, climate, and vegetation all act as controls in determining the distribution of wild animals. But when we come to man it is wiser to talk of the " influence " rather than the " control " of the environment, in determining his distribution and activities. There is, really, a reciprocal control between man and nature: in certain respects nature retains virtually absolute control—thus no man can place a coalfield where nature has not provided one—in other respects man is able to overcome nature—as, for example, by irrigating otherwise arid and useless tracts. The more backward and uncivilized peoples are slaves to their environment ; the more advanced the civilization the greater man's control over his environment. We have only space here to consider a few of the geographical factors of man's environment.

Topography or Physical Features.—Viewed dispassionately, man's efforts to alter the major physical features of the earth are puny in the extreme. They are restricted very largely to the improvement of communications by tunnelling for railways through the great mountain chains or building roads across them. Of great importance may be quoted the draining of swamps, and the reclamation of areas of shallow sea, as in the Zuyder Zee. Rugged, mountainous country cannot be made into fertile plains and, generally speaking, the great mountainous regions of the world must remain thinly populated areas. Here and there patches of dense population mark mining activities ; but even where mountain pastures or carefully terraced hillsides have been turned to account, the population is concentrated mainly in the broader valleys. Even the " tourist industry " of the Alps, the hill-stations or health resorts of the Himalayas or Rockies, are but the exceptions which prove the rule. In comparing a physical map of a continent with a population map, and noticing the concentration of the population on the lowlands, it must be remembered that in some parts of the world there are huge tracts of fertile, comparatively level land at relatively high altitudes. This is particularly the case in North America and Africa. It is the *rugged* mountainous tracts which are thinly populated.

Physical features have also influenced customs and habits. It is sufficient to point to the seafaring Norwegians as the natural product of the fiords, and to the parochial hill tribes of the Himalayas.

Geology.—The distribution of man is influenced both by the disposition of the stores of valuable minerals, and also by the character of the soils. Coalfields are most usually marked by a local increase in density of population; in most countries the concentration of manufacturing industries on the coalfields accentuates this. Oilfields and metalliferous mining fields do not necessarily attract other industries, and are marked by an intense, but often very local concentration of population.

The influence of soil is most obvious in the great alluvial tracts of the world—the Ganges Valley, the Yangtze Valley, the Nile Valley and Delta, and the Po Valley are examples which suggest themselves at once. The importance of a rich soil or soil of special character is seen in the black cotton soil of the Indian plateau; the Black Earth of South-Western Russia, or the rich volcanic soils of Java, where rice cultivation is carried thousands of feet up the sides of extinct volcanoes to take advantage of the richness of the soil. It will be seen that soil, by influencing agriculture, influences the distribution particularly of agricultural populations.

Climate.—Man can do little to control temperature. He cannot mitigate the fierce heat of the tropics, nor can he prevent the cold of winter freezing the Great Lakes or the Siberian rivers. The most he can do is to adapt his life and his needs to climatic requirements. He can build houses with thick walls, shady verandas, electric fans, and refrigerators in the tropics, and wear white cotton clothing; he can build double-windowed, centrally-heated houses in the cold regions of the north, and wear thick woollen clothing. Man's food is also adapted to climatic requirements—as witness the rice diet of the Indian coolie, and the diets of Northern races in which meat and animal fats are staple articles.

Whilst man cannot control rainfall, an adequate supply of suitable water of other origin can take the place of rain, whether it be for crops, stock, or human consumption. Where such extraneous supplies of water are not available, the influence of rainfall in determining the distribution of mankind is paramount. For agriculture 10 inches per annum may be regarded as a normal minimum in temperate lands, 20 inches in the tropics. Fig. 55 shows those regions of the world where these conditions are not satisfied. Fig. 56 is a population map of the world. It will be seen that there are few regions of the world with less than these

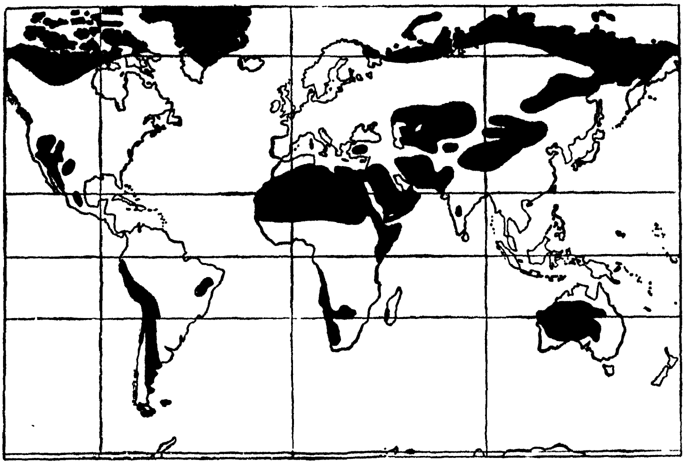

FIG. 55.—Map of the World showing regions deficient in rainfall.

All parts shown in black in the tropical regions receive less than 20 inches per year; in the temperate and cold regions less than 10 inches per year. (*After "The Times" Atlas.*)

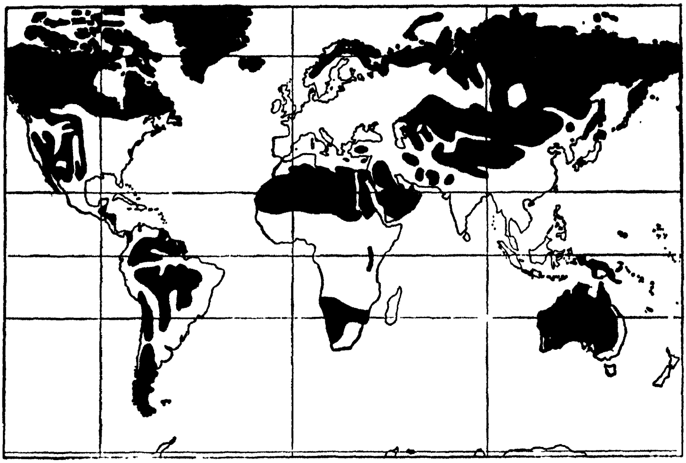

FIG. 56.—Map of the World showing thinly inhabited regions.

All parts shown in black have less than two people per square mile. Notice that these thinly peopled regions correspond very closely with the regions of deficient rainfall shown in Fig. 55. (*After "The Times" Atlas.*)

amounts of rain where the density of population exceeds two persons per square mile.

It is a little difficult to say what is the "ideal climate" for man's development. The great civilizations of the ancient world—Greece, Rome, Carthage, Minos, and to some extent Egypt, Assyria, and Babylonia—are concentrated in a remarkable way in the region of Mediterranean Climate. Other great civilizations have a tropical seat of origin—India, Mexico—others warm temperate—China in particular. In these warmer climes there is a tendency for maturity in the individual to be reached at any early age. Even in India to-day most of the women are mothers before reaching the age of twenty years; senility is apparent at correspondingly early ages. Similarly it would seem that civilizations in warmer climates matured early. In colder climates development of the individual is slower, and national development has also been slower. White peoples to-day are accustomed to regard as ideal a climate which is sufficiently cool to encourage outdoor manual work the whole year, and has, in addition, a winter sufficiently cold to be regarded as invigorating. At the same time a pleasant amount of sunshine and an absence of fog and mist are eminently desirable.

Climatic influence is apparent in the mental outlook, both of individuals and nations. Quick temper and hastiness, accompanied by a cheerful but lazy disposition, tend to be characteristic of warmer climates, and a more sluggish but steadier disposition of colder regions. Historical geographers are fond of enlarging on the astronomical and mathematical attainments of the Egyptians as in large part the result of life in a land of clear skies and trackless desert, where the stars afford a practical guide to the traveller, and a source of inspiration to the philosopher.

Vegetation.—We have seen that the natural vegetation of the world is a result of the interaction of climate and the physical structure of the surface. When studying the distribution of man, it is difficult to separate the influence of the natural vegetation, as such, from that of the climate. But of the influence of vegetation we may instance the retarding influence of such "regions of lasting difficulty" as the equatorial forests, where the luxuriance of vegetation overpowers even the activities of modern man—resisting his attempt at clearance, and often engulfing the puny clearings or plantations he may succeed in making. On the grasslands man may throw in his lot with the grass-eating animals, and become a pastoralist, or be classed with the carnivores as a hunter. In either case he is essentially a nomad. Agriculture follows later, when the luxuriance of natural grassland gives place to the luxuriance of grasses carefully "improved" by man as cereals.

If we compare the present-day distribution of man with the areas covered by certain of the climatic regions, we notice his concentration:

(*a*) In Monsoon lands and warm temperate lands with the "China Type" or "Gulf Type" of climate;

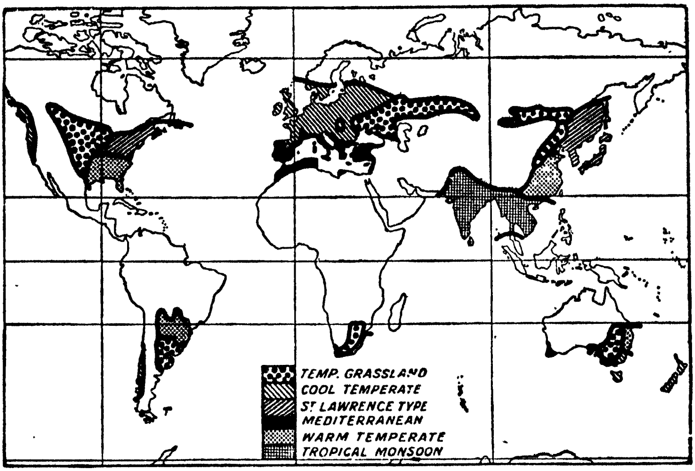
TEMP. GRASSLAND
COOL TEMPERATE
ST LAWRENCE TYPE
MEDITERRANEAN
WARM TEMPERATE
TROPICAL MONSOON

Fig. 57.—The favourable climate regions—Monsoon climate, Warm Temperate Oceanic (China and Gulf types), Mediterranean Climate, Cool Temperate Oceanic, St. Lawrence type, and Temperate Continental Climate.

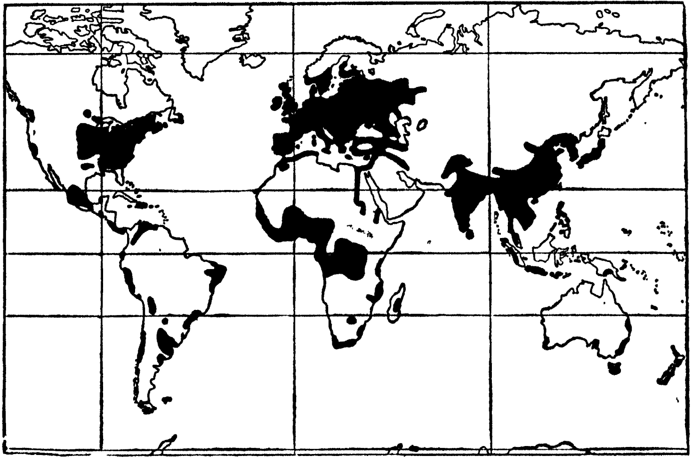

Fig. 58.—Map of the World showing in black all regions with more than 26 people per square mile.

Notice how closely these correspond with the climatic regions marked on Fig. 57.
(*After "The Times" Atlas.*)

(*b*) In Mediterranean lands;

(*c*) In cool temperate lands, in the Deciduous Forest, St. Lawrence type, and Temperate Grassland.

Population is still sparse in the equatorial and most tropical regions; in the cold temperate coniferous forest belts, and in deserts of all types.

Industrial Centres.—Summarizing, we may say that the distribution of man on the surface of the earth is determined primarily by the character of the surface and the climate. Minerals have an important influence in promoting local segregation. The concentration of population in the great industrial regions of the world usually owes its inception to geographical factors—the coalfields form a good example—but in its later stages is largely independent of geographical factors. In a way a "vicious circle" is started, vast communities may be built up of people living, virtually, upon one another. In some respects Sydney or Melbourne in Australia afford examples. On a purely geographical basis it is difficult to account for those huge cities. But a city, once established, needs food, hence local and foreign trade, wholesale and retail. A well-fed population needs work, and affords a supply of labour. Labour being available and a large population affording a market manufacturing industries arise. Manufacturers supply the people who supply the labour for their factories. The consideration of these matters is beyond the scope of geography; they are mentioned here to avoid the misconception that geographical factors are the only ones to be considered. A subject of great interest is the study of town sites. Certain geographical advantages, sometimes difficult to discover except from a study of historical records, throwing light on early conditions, have usually determined the site of a town in the first place. Students are recommended to select certain towns and endeavour to trace the advantages of their position.

THE RACES OF MAN

Mankind is frequently divided into three races—the White, the Yellow, and the Black. This is unsatisfactory in many ways—for one thing the "White" race includes most of the brown-skinned races of India; the Yellow race the brown-skinned Malays. It is probable, too, that skin-colour depends largely on exposure to the sun. We can divide the races of mankind, more scientifically, into these groups by their hair.

(1) Peoples with straight hair. Under the microscope a section of the hair is circular. These people often have yellowish skins, and broad, flat faces with high cheek-bones. They correspond roughly with the peoples usually called "Mongolian." Some of them, like the Chinese, have almond-shaped eyes set obliquely. The American Indians who used to inhabit most of America, have a copper-red skin and straight hair, but they have larger noses

than the normal Mongolians. The typical straight-haired peoples are the Chinese and Japanese.

(2) Peoples with wavy hair. A section of the hair under the microscope is oval. The wavy-haired peoples constitute the Indo-European division of mankind, including most of the inhabitants of Europe and India. Their skin varies from white to dark-brown. They usually have narrower faces than the Mongolians and their noses are more pronounced.

(3) Peoples with curly or woolly hair—hair which forms into tight curls all over their heads. Under the microscope their hair is seen to be flattened in section. The negroes belong to this group. They usually have very dark skins, almost black.

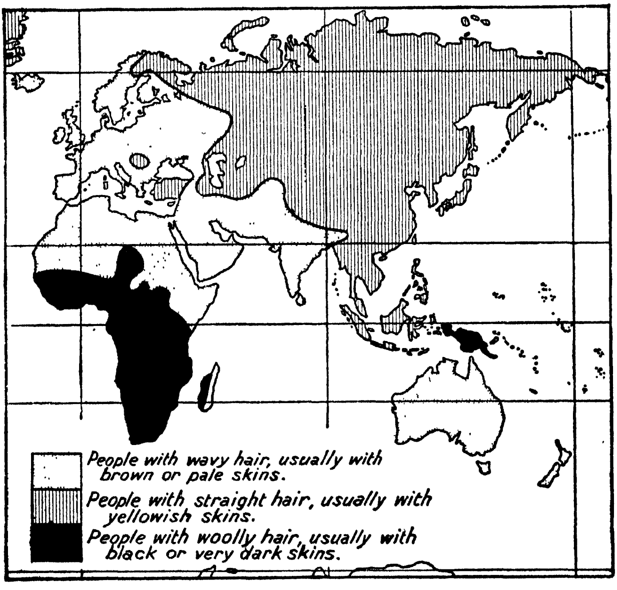
People with wavy hair, usually with brown or pale skins.
People with straight hair, usually with yellowish skins.
People with woolly hair, usually with black or very dark skins.

FIG. 59.—The Races of Man.

America is not shown because it is mainly inhabited by people who have left Europe and settled there during the last 300 years. There are now very few "American Indians" who had straight hair.

LANGUAGE

We cannot here deal with the varied languages of mankind. It should be noted that a small number of languages have spread to all corners of the globe, and are recognized as the "languages of commerce." Their distribution is shown in Fig. 60.

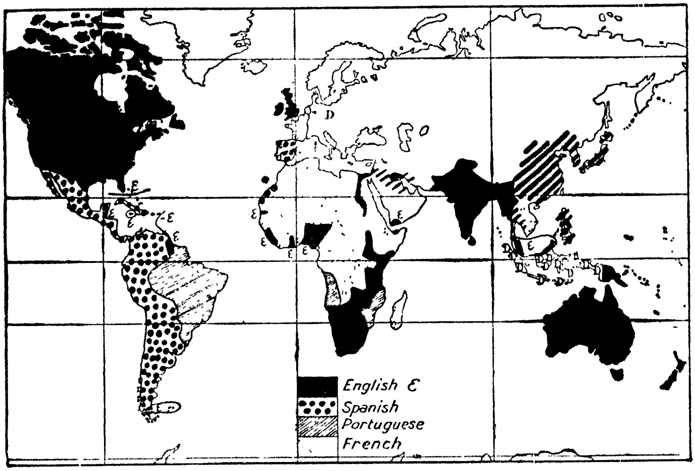
English E
Spanish
Portuguese
French
D
E
O

FIG. 60.—The Languages of Commerce.
D = Dutch. Striped regions are those where English is largely used.

POLITICAL DIVISIONS

Fig. 61 shows the population of the principal empires of the world.

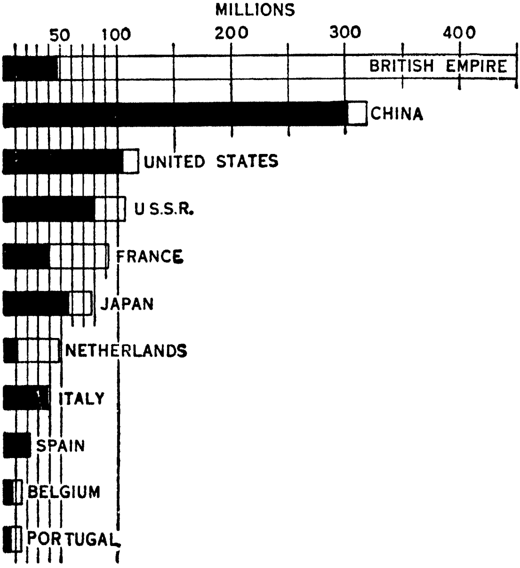

FIG. 61.—The population of the principal countries of the world.
Home country in black, foreign possessions in white.

EXERCISES

1. On an outline map of the world, show in solid black all areas more than 3,000 feet (or better 4,000 feet) above sea-level. Compare this with the population maps, Figs. 56 and 58, and say what you notice.

2. On an outline map of the world mark in solid black all areas of deficient rainfall (as in Fig. 55). Then shade in from Fig. 58 the more densely populated parts of the world. The intervening areas will be those with a sufficient rainfall but still sparsely populated. Which of them do you think capable of development ?

3. Draw a map of the world showing the principal industrial regions. Make a list of them and notice the type of climate in which each occurs. Write some general conclusions from this.

4. Draw a map of the world showing the empires or political divisions mentioned in Fig. 61.

5. From figures given in the *Statesman's Year Book* draw a diagram to show the comparative *sizes* of the principal countries in the world.

EXAMINATION QUESTIONS

1. Write a brief explanatory account of the geographical factors determining the distribution of population the world over. (*Univ. Bristol Inter.*, 1925.)

2. How far is the study of man's physical environment indispensable to the study of his economic activities ? (*Univ. Toronto, 1st Year Pass*, 1924.)

3. Discuss the influence of climate upon man. (*Univ. British Columbia Sessional*, 1925.)

4. "Man's character and occupation have been decided by the geographical conditions under which he lives." Illustrate this with reference to Englishmen and Burmans, *or* any other race living in the tropics with which you are familiar.

5. Towns spring up at—

   (*a*) The limit of ocean navigation.
   (*b*) The limit of river navigation.
   (*c*) At bends in rivers.
   (*d*) At the confluence of two rivers.
   (*e*) At waterfalls.

Give two examples of each of these, drawing a small neat diagram for each town showing the advantages of its position. (*Govt. Burma, Matric.*, 1924.)

6. Write an account of *either* the people who live in the cold forests of Russia and Northern Siberia, *or* the Kaffirs who live in the grasslands of South Africa, using the headings—

   (1) Where they live—climatic and other conditions.
   (2) The houses they live in—their clothes—their food.
   (3) Their occupations—brief description of how they carry them on.
   (4) How they travel.

Illustrate your answer, if you can, with drawings of their houses, weapons, and anything else interesting.

7. Analyse the local geographical factors concerned in the situation of any one of the larger English cities. (*Univ. London Inter. B.Sc. Econ.*, 1930.)

8. What geographical factors would you take into consideration in discussing the site and development of a port ? Illustrate with examples from the continent of Europe. (*Univ. London Inter. B.Sc. Econ.*, 1930.)

9. Analyse the geographical conditions that have contributed to the growth of dense populations (*a*) in industrial regions and (*b*) in temperate agricultural regions. (*Univ. London Higher Schools B & D*, 1932.)

10. What geographical reasons have been suggested for (*a*) the sparseness of population in tropical South America and (*b*) the great density in tropical Eastern Asia ? (*Univ. London Inter. B. Com.*, 1932.)

CHAPTER VI[1]

CEREALS

THE primary and universal need of man is food, and foremost amongst his foodstuffs stands grain or cereals. Some kind of grain forms the basis of the diet of over 99 per cent. of mankind; the small minority being formed by such primitive tribes as the fish-eaters of the frozen north, certain fruit- or root-eating denizens of the equatorial forests, and desert tribes subsisting mainly on dates. Vast quantities of grain are also grown as food for those animals which have been domesticated by man.

Judged according to the area occupied by the growing crops and the estimated world yields the leading cereals are as follows: [2]

Crops	Area in millions of hectares			Area in millions of acres			Production in millions of metric tons		
	1909–13	1921–25	1930–34	1909–13	1921–25	1930–34	1909–13	1921–25	1930–34
Wheat . . .	109	104	128	269	257	320	103	98	119
Maize . . .	72	73	63	180	180	157	106	108	106
Oats . . .	58	55	54	143	135	135	65	60	58
Rice . . .	49	54	43	120	133	107	77	85	82
Rye . . .	44	41	37	110	102	92	45	39	48
Barley . . .	34	30	38	85	75	95	37	32	35

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[1] *Chapter VI.*—All tables and diagrams in this chapter may be completed or brought up to date from the *International Year Book of Agricultural Statistics* (International Agricultural Institute, Rome).

For more detailed maps showing distribution of the cereal crops, reference should be made to *Philips' Chambers of Commerce Atlas* or to *Finch and Baker's Geography of the World's Agriculture*.

Conversion Tables:

1 metric ton = 10 quintals of 100 Kg. each = 1,000 kilograms = 2,200 lbs. = 36·7 bushels of wheat (approx.).

1 ton avoirdupois = 2,240 lbs. = 1,016 Kgs. = 37·3 bushels of wheat (approx.).

1 quarter (wheat) = 8 bushels of 60 lbs. each nominally.

1 hectare = 2·47 acres.

Yield in quintals per hectare × 1·5 = yield in bushels per acre approximately (wheat, maize, or rye).

1 bushel of wheat averages 60 lbs.

1 bushel of barley averages 56 lbs.

1 bushel of oats averages 39 lbs.

1 bushel of maize averages 60 lbs.

1 bushel of rye averages 60 lbs.

1 bushel of paddy averages 45 lbs., of rice (husked) 67–68 lbs.

[2] To be kept up to date from *International Year Book of Agricultural Statistics*, or the *Monthly Crop Report of the International Review of Agriculture*. All figures rounded.

The above figures are not complete, as there are some countries of which no statistics are available. The most important of these is China. Taking into account *all* areas of production the world's total production was estimated by the International Agricultural Institute as follows (1937–8 Yearbook):

Wheat .	1,200 to 1,300	million quintals	or	120–130	million metric tons
Maize .	1,000 to 1,300	,,	,,	100–130	,, ,,
Oats .	600 to 700	,,	,,	60– 70	,, ,,
Rice .	1,200 to 1,300	,,	,,	120–130	,, ,,
Rye .	400 to 500	,,	,,	40– 50	,, ,,
Barley .	400 to 450	,,	,,	40– 50	,, ,,

The only serious discrepancy in this table is in the case of rice.

Of the cereals not enumerated above, the most important are the various small grains collectively known as millets. These form the staple food grains of the native population over most of the drier parts of tropical and subtropical Asia and Africa.

From the point of view of production wheat, rice, and maize are roughly of equal importance. From the point of view of international commerce their relative importance is, however, very different. This is shown by the following table, which gives the total world trade exports in each of the cereals:

World Trade—Exports

	Million metric tons			Percentage of world production exported		
	1909–13	1924	1936–37	1909–13	1924	1936–37
Wheat	14·5	17·8	15·3	17	24	15
Wheat flour[1] . .	2·1	3·8	2·3			
Maize	6·3	6·8	10·7	6	6	9
Oats	2·3	1·5	0·8	4	2·6	1
Rice	4·4	5·1	7·7	6	6[2]	8[2]
Rye	2·1	2·1	1·0	3	6	3
Rye-flour	0·3	0·1	0·1			
Barley	5·2	2·9	3·0	14	10	7

[1] 100 of wheat flour=133 of wheat. [2] Only about 4 if China is considered.

It will be noticed that, from the point of view of international trade, wheat is the most important cereal; in some years nearly a quarter of the total crop is exported, *i.e.* enters into international trade. The growth of nationalism and the general restriction of international trade has witnessed a diminution of the movements of wheat but a growth in those of maize, used mainly as feed for animals.

It will be desirable to consider now each of the cereals in some little detail. It may be noted at once that the cereals fall into two groups:

(*a*) The cereals of cool temperate lands—wheat, barley, oats, and rye.

(*b*) The cereals of warm temperate and tropical lands—rice, maize, millets, and wheat. Wheat in tropical lands is grown as a winter crop.

Yield of the Principal Cereals—World Averages.

	Quintals per hectare		Bushels per acre	
	1909–13	1930–34	1909–13	1930–34
Wheat	9·4	9·3	14·0	13·9
Barley	11·2	9·2	17·8	12·9
Oats	11·4	10·7	26·0	25·0
Rye	10·1	13·0	15·0	19·5
Rice	16·1	19·8	31·9	39·5
Maize	14·7	16·8	21·8	24·0

WHEAT

Cultivated wheat is a grass (order Gramineæ) belonging to the genus *Triticum*. It was the staple food of Egyptians 3,000 and 4,000 years ago, and there is evidence that wheat was known in Switzerland in the Stone Age. There are countless varieties which have been evolved to meet the special requirements of local conditions. In general two main groups may be separated :

(*a*) Winter wheats, which are sown in the autumn, lie in the ground (often protected from frost by a layer of snow) during the winter, germinate in the spring, and are reaped in the late summer.

(*b*) Spring wheats, which are not sown until the spring though are ready for reaping at the same time as the winter wheats.

Wheat is the most valuable of all the grains, and the chief foodstuff of the white races. Typically a cereal of temperate lands its use is extending in tropical lands, especially in India.

Conditions of Growth.—The best soil for wheat is a heavy loam or a light clay, though both light sandy or chalky soils and heavy clays may produce good crops provided they are rich in plant foods. Good drainage is essential, and the best wheat lands (such as the Prairies) are gently undulating. At the same time, for extensive cultivation the land should be sufficiently level for mechanical methods of ploughing, sowing, and reaping. The "black soils" of the European steppes and the American prairies, which owe their dark colour to their richness in nitrogenous material—the result of an age-long succession of prairie fires—produce wheat of excellent quality. But wheat is an exhausting crop, and after the initial richness of virgin soil has been absorbed, systematic manuring or rotation of crops is essential. Sulphate of ammonia, nitrate, and farm manure are the usual manures.

Climate is more important than soil in the cultivation of wheat. The essentials are moisture and cool weather during the period of ermination and early growth; warm and bright weather when the eads have formed; a little moisture in order to swell the grain efore ripening; and finally a bright, sunny harvest. The yield lepends largely on the number of stalks formed, but it is only in cool, moist weather that the plant "tillers" well; hence the need of the cool, moist spring. Winter wheats can be grown where the cold of winter is not so intense as to freeze the ground and injure the seed (*e.g.* England); spring wheat where the winter cold is more severe (*e.g.* Canadian prairies). In tropical regions, and notably in the Monsoon land of North-West India, the requirements of wheat are obtained by adapting seedtime and harvest to the local climatic conditions. The seed is sown after the "rains," grows during the "cool season," ripens, and is harvested before the extreme scorching heat of the "hot season" ruins it. It is, in other words, a "winter crop."

With regard to temperature, a growing season, after the last frost, of 90 days or more is needed and a temperature of at least 60° for the ripening of the grain. The great wheat lands have three months with an average temperature of over 60°, but in certain more northerly lands the great length of summer days may compensate in some degree for the shortness of the season. The July isotherm of 60° marks roughly the extreme northern limit.

An annual rainfall of from 15 inches to 35 inches characterizes the great wheat lands. The continental grasslands with their winter snows melting in the spring, and with their light spring rain, are eminently suitable. In Australia the best wheat lands have a rainfall of between 20 and 30 inches; the grain can be cultivated with as little as 8 inches by "dry farming."

It is curious that the character and quality of the grain varies greatly according to climatic conditions. The wheat of warm dry lands (Mediterranean and Tropical Monsoon Climates) is hard; American wheats are characteristically of the "red" type; Australian are white. Macaroni, vermicelli, and allied products are made from hard wheats. In selecting varieties for cultivation high yield per acre, resistance to disease, strength of the straw, hardness and whiteness (for the best flour) are points to be kept in mind.

World Production.—Fig. 62 shows the principal wheat-growing countries of the world. It will be observed that all of them, excluding India, lie in temperate latitudes, and even in India the principal wheat lands are actually outside the tropics.

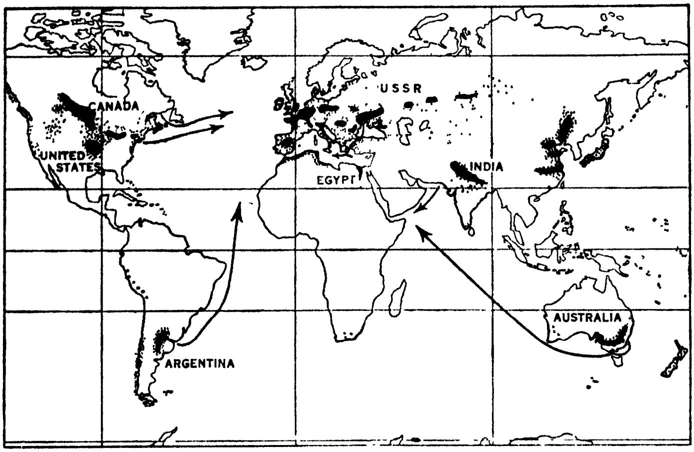
CANADA
UNITED STATES
USSR
EGYPT
INDIA
AUSTRALIA
ARGENTINA

Fig. 62.—Map of the World showing the principal wheat-growing countries.
Arrows indicate direction of export trade.

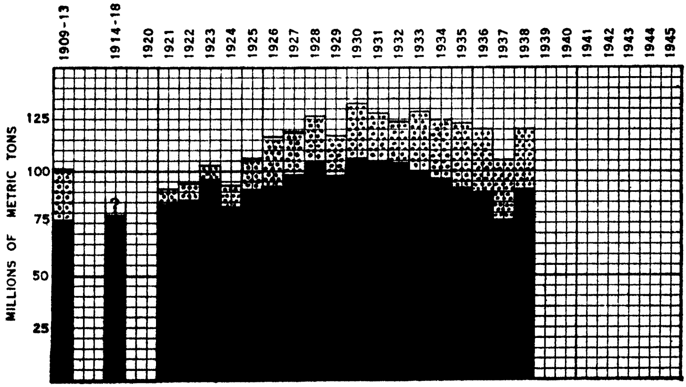

Fig. 63.—World production of wheat in recent years.
The dotted portion indicates the Russian production (U.S.S.R., including both European and Asiatic territories).

Fig. 63 shows the fluctuation in recent years in world production. The cultivation and use of wheat are still steadily extending. This, however, is not apparent from the graph, because the growth in such countries as Canada, Argentina, and Australia was offset by the large temporary drop in the production of the U.S.S.R.,[1] the result of the political upheaval.

The following table shows roughly the distribution of the wheat production, expressed as approximate percentages of the whole:

	1909–13	1924	1929	1934
Europe (excluding U.S.S.R.) . .	37	31	35	35
North America (Canada and U.S.A.)	24	33	27	18
Asia (excluding U.S.S.R. and China)	10	12	9	12
North Africa	2½	2½	3	3
South Africa	0·2	0·2	0·3	0·3
Australasia	2½	5	3	3
South America	5	6½	5	7
U.S.S.R.	19	10	18	22

The wheat-growing countries may be divided roughly into two groups:

(*a*) Those which grow wheat for home consumption, and which are either just self-supporting, or in which the deficiencies in local supply are made up by imports. Most of the European countries (excluding Russia) belong to this group. Hungary is the only one showing an export surplus of over 100,000 tons in 1934.

(*b*) Those which grow wheat largely for export as well as for home consumption. The important wheat-exporting countries are few in number; they are mainly "new" countries where the wheat lands are still being extended. In order of importance they are Canada, Argentina, United States, Australia, India (in years when there is a surplus), and Russia.

There is a marked difference in methods of cultivation between the two groups of countries. It has already been noted that wheat is an exhausting crop. In the older countries, where land is expensive and the area is limited, intensive cultivation is practised. Wheat is grown every third or fourth year, in rotation with a root crop, a leguminous crop (for fodder or hay), and possibly grass. Manuring is general, the seed is thickly sown, and a large yield per acre is looked for. Examples of high yields (1931–34 averages) are given in the following table:

Denmark . .	28·9	quintals	per hectare	or	43·3	imperial	bushels	per acre
Germany . .	21·6	,,	,,	,,	32·4	,,	,,	,,
Holland . .	29·9	,,	,,	,,	44·8	,,	,,	,,
Great Britain .	22·3	,,	,,	,,	33·5	,,	,,	,,

It should be remembered, however, that a large quantity of seed is used. In Great Britain about 2½ bushels to the acre is a common amount, so that the yield is about 12- or 13-fold.

---

[1] U.S.S.R.=Union of Socialist Soviet Republics, *i.e.* Russia in Europe and Russia in Asia.

In the newer countries, where vast areas of land are available, but where the smaller population often makes labour expensive and encourages the use of mechanical methods of ploughing, sowing, and reaping, extensive cultivation is characterized by a much smaller yield per acre. The seed is, however, much less thickly sown. Examples of yields are as follows (1926–29 average):

Canada . . .	12·6	quintals per hectare or	18·9	imperial bushels per acre
U.S.A. . . .	9·9	„ „ „	14·7	„ „ „
Australia . .	7·3	„ „ „	11·0	„ „ „
Argentina . .	8·7	„ „ „	13·0	„ „ „
U.S.S.R. . .	7·2	„ „ „	10·8	„ „ „

In Australia an average of 0·9 bushel of seed per acre is used, giving a yield, closely comparable with that of Great Britain, of about 12-fold. In the warmer Mediterranean countries the yield is generally small, as it is in tropical countries such as India:

Spain (1926–29)	. . . . .	8·9 quintals per hectare
India „	. . . . . .	6·8 „ „ „

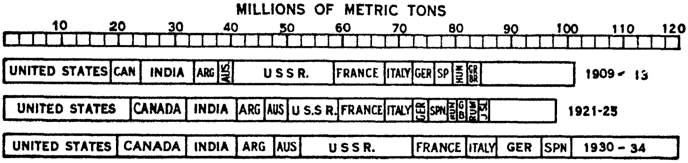

FIG. 64.—Production of wheat in the principal wheat-growing countries.

Notice the increase in the production of the United States, Canada, and Australia, and the drop in the Russian production As in all the graphs in this chapter the 1909–13 figures relate to the *same areas* of those of 1921-25 and 1933 Thus the figures for U S S R are strictly comparable.

The Principal Wheat-growing Countries.—*Europe* (excluding Russia).—In normal times Europe, even excluding Russia, produces between 30 and 40 per cent. of the world's total, and consumes over 50 per cent. of the world's output. The Mediterranean lands grow large crops, especially of hard wheats, but the climate is too dry for a high yield per acre. Italy is no longer self-sufficing, although the yield has been increased to 14·7 quintals per hectare. The Spanish plateau has over 11,000,000 acres under wheat, but the yield is only 9·5 quintals per hectare (1931–34).

In North-Western Europe, with a Cool Temperate Oceanic Climate, wheat characterizes the drier, sunnier parts. In Great Britain, the east and south-east scarplands—with a rainfall between 20 and 30 inches—give a high yield per acre, but the West of England is too wet and the North of Scotland too cold. France has a larger area under wheat than any other European country (excepting

Russia), but the yield is low. The chalk scarplands of the north-east and the drier parts of the west are the main areas of production. Holland and Belgium have, in proportion to their size, considerable areas under wheat.

In countries with a Central European type of climate Germany's large production is the result of careful scientific cultivation in the southern part of the German plain. The Hungarian, Rumanian, and Bulgarian plains have climatic conditions approaching those of the great grasslands of the world, and produce large crops of first quality hard wheat.

Russia.—The great grasslands of Southern Russia—the Steppes—are to be numbered amongst the great granaries of the world. The wheat belt stretches from Rumania, through the "Black Earth" region of Ukraine, north of the dry Caspian region, into Southern Siberia. Before the war this great tract yielded nearly a fifth of the world's total, and is gradually returning to its pre-war importance. The wheat is shipped largely from the Black Sea ports. The coldness of the winters over most of this region makes the use of spring wheats general, in contrast to the winter wheats of the remainder of Europe. Great expansion is still possible in Siberia. In 1930 Russia became easily the largest wheat-producer.

North America.—The prairies of Canada and the northern United States form the great wheat belt, but extensive crops are also grown in the Mediterranean land of California, on the plateaux amongst the Rocky Mountains, and in the eastern States and southern Ontario. Between 1913 and 1923 Canada more than doubled her wheat crop, and is now the world's largest exporter. The majority of Canadian wheat is spring wheat, as the prairie winter is too severe for winter wheat except in South-West Alberta, where the warm Chinook winds mollify the winter cold. The prairie provinces of Manitoba, Saskatchewan, and Alberta yield about 92 per cent. of Canada's crop; Winnipeg is the collecting centre for the crop and the world's leading grain market. The wheat belt is limited by cold on the north and by drought on the south-west. The wheat grown in Southern Ontario is mainly winter wheat. For further details see the section on Canada in Part II.

The Canadian spring wheat area extends southward into the United States, notably in the prairie west of the Red River in North Dakota. Further south a broad belt of winter wheat stretches from North-Eastern Colorado to New York and New Jersey, the central block of which, lying in South Nebraska, Kansas, and Oklahoma, has now become the chief wheat area of the United States. For further details reference should be made to the section on the United States.

Asia.—The large Indian crop is grown mainly in the United Provinces, the Punjab, and the North-West Frontier Province.

The cultivation and use of wheat is, however, spreading southwards into the Deccan. The Indian wheats are hard wheats, favoured by Italian millers rather than British, and are grown as cold season crops mainly on irrigated alluvial lands. The surplus available for export varies, in the years following the war it was small, since 1929 there has been an import, frequently larger than the export. The trade is handled by Karachi. Both Japan and Northern China produce large crops of wheat, but almost entirely for home consumption. Of all countries in the world where great expansion in wheat cultivation is still possible, perhaps the most important of all is Manchuria.

North Africa.—Egypt was the granary of the ancient world, the wheat crop being produced on the fertile Nile alluvium. Though the yield is lower than that of certain European countries, it is very high when compared with other lands in comparable latitudes. The Mediterranean lands of Morocco, Algeria, and Tunis have considerable areas under wheat.

South Africa.—Small quantities of wheat are grown in the Mediterranean region of South Africa, but the grasslands of the High Veld are suited to maize rather than to wheat.

Australasia.—There are two principal wheat belts in Australia, both in the temperate portions of the continent. One, in the south-east, stretches from South Australia through Victoria and New South Wales, lying roughly between the rainfall lines of 10 and 30 inches. The other belt is in the Mediterranean region of Western Australia, lying between similar rainfall limits. For further details see the section on Australia. Australian wheats are of the " white " type, in contrast to the American " red " wheats.

South America.—After Canada, Argentina and the United States are close rivals for the second place as exporters of wheat. The wheat belt lies round the River Plate and stretches into Uruguay. Considerable quantities of wheat are also grown in Chile.

World Trade in Wheat and Wheat Flour.—In 1909–13 the average annual export of wheat (excluding flour) was 14½ million metric tons. Roughly 95 per cent. of the total was absorbed by Europe. In 1931–34 the average annual export was 20 million tons, again the bulk being taken by Europe. World trade in wheat, as indicated by the arrows on Fig. 62, is thus mainly between the five great exporters—Canada, Argentina, United States, Australia, and India—and the countries of Europe.

Fig. 65 shows the leading countries in the wheat trade in 1909–13; Fig. 66 shows the position in 1921–25. The diagrams speak for themselves. The effect of the disorganization of Russia and the spread of wheat cultivation in Canada are very striking. In 1930–31 Russia again became a large exporter.

Some idea of the enormous value of the wheat trade may be taken by giving some average values per bushel of 60 lbs. :

	1913	1924	1929	1934
Winnipeg, No. 1, Northern Manitoba	\$0·88	\$1·28	\$1·33	\$0·79
Chicago, No. 2, Winter	\$0·90	\$1·26	\$1·23	\$1·14
Liverpool, No. 1, Manitoba . . .	4*s.* 6*d.*	6*s.* 8*d.*	6*s.* 1*d.*	8*s.* 11*d.*
Liverpool, Australian	4*s.* 7*d.*	6*s.* 8*d.*	5*s.* 9*d.*	7*s.* 9*d.*
Liverpool, Plate	4*s.* 6*d.*	6*s.* 4*d.*	5*s.* 4*d.*	6*s.* 8*d.*

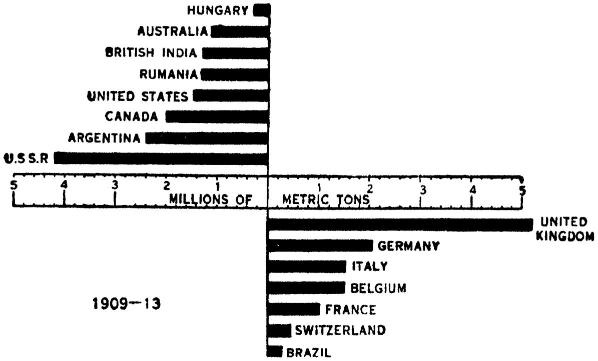

FIG. 65.—Wheat trade of the world, 1909–13—principal exporting countries (above) and principal importing countries (below).

All export and import diagrams in this chapter relate to *net* exports and imports, that is, the surplus of exports over imports or imports over exports.

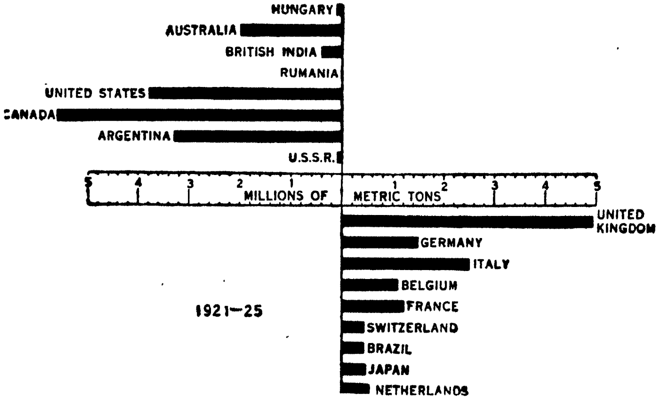

FIG. 66.—Wheat trade of the world, 1921–25.

Notice the extraordinary changes in the principal exporting countries.

Taking these as rough indices of value applicable to the whole world, the 14·5 million tons exported in 1909–13 (average) would be worth, at Winnipeg or Chicago prices, about \$475,000,000 or nearly £100,000,000, and the 13·8 million tons imported in 1909–13 would be valued at London or Liverpool prices about £115,000,000 or $560,000,000. These figures are increased by nearly 20 per cent. if the value of the trade in wheat flour is considered.

In 1934, on the same basis, the 14·3 million tons exported would be worth about $1,400,000,000, and the 12·7 million tons imported nearly £500,000,000. These figures are increased by nearly 30 per cent. if the value of the trade in wheat flour is considered.

Of all recent developments in the trade in wheat, that of bulk handling is the most important. Among the great exporters it is now the rule in Canada and the United States, and to a considerable extent in Argentina; it is in course of adoption in Australia, and will doubtless in time spread to India. The grain, delivered to the grain elevator at the local railway station, is dried (when necessary), stored, graded, railed, shipped, and delivered without recourse to bags. As a distinct contrast is the Australian "Complete Harvester," which performs in one machine all processes from the cutting of the wheat to the bagging of the grain. The effect of this spread of bulk handling on the trade in Indian gunny bags or jute sacks should be noted.

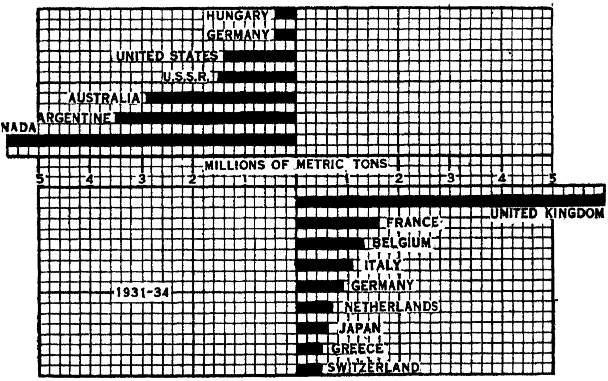

FIG. 67.—Wheat trade of the world, 1931–34.

Another important matter to be considered in the wheat trade is the milling of the wheat. Successful milling requires a rather dry climate, and those wheat-growing centres which have a suitable climate mill their wheat and export it in the form of flour. In 1909–13 the average export of wheat flour was 2·2 million tons, the import 2·1 million tons. In 1929 the corresponding figures were 3·8 million tons and 3·7 million tons—indicating a rapid growth in the practice of milling wheat before export. The increase is particularly marked in the case of Canada and Australia. In calculating quantity of wheat, 100 of flour is generally taken as equivalent to 133 of wheat. In 1934 the export of flour dropped to 2·6 mn. tons.

The importance of the wheat trade to ocean shipping may be gauged by the following table of ocean freights :

	1913	1924	1929	1934	
North America to England .	12*s.* 1*d.*	15*s.* 2*d.*	12*s.* 8*d.*	9*s.* 7*d.*	per ton of 2,240 lbs. or 1,016 kgs.
Plate River ports to England	18*s.* 2*d.*	26*s.* 2*d.*	21*s.* 8*d.*	14*s.* 11*d.*	
Australia to England . . .	31*s.* 3*d.*	39*s.* 10*d.*	30*s.* 1*d.*	23*s.* 10*d.*	

A very rough calculation shows over £10,000,000 paid in freights in 1913 or £13,000,000 in 1929 and £10,000,000 in 1934.

BARLEY

Barley (*Hordeum vulgare*) is, like wheat, a cultivated grass. It differs from wheat in that the spikes instead of standing erect, droop downwards. This characteristic, coupled with the very long awns, make barley one of the most beautiful of standing crops. Barley was the chief bread-plant of the ancient world, and is one of the oldest, if not the oldest, of cultivated grains. This is largely due, no doubt, to its productivity—greater than that of wheat—in the Mediterranean climate in which the ancient civilizations flourished. Barley is still largely used as human food in Japan, India, Scandinavia, and North Africa, and barley-bread was once common in Scotland. But barley bread is heavy, and as human food barley has been largely replaced by wheat. One of the chief uses of barley is now for the preparation of alcoholic drinks. The grain is allowed to germinate (whereby the starch is largely converted to sugar) and then killed. Beer is an infusion made by fermenting the resulting malt ; whisky is manufactured by distillation. Barley is also important as a food for stock.

Conditions of Growth.—Barley has the widest range of all cereals. The best barley flourishes under conditions suited to wheat, but in addition barley will grow on poorer soils. Barley is also able to mature very quickly even at low temperature, and can thus take full advantage of the short northern summers or the brief warm spells of high mountain valleys. It is thus cultivated further north than any other grain—well within the Arctic Circle in Norway—and higher up the mountain slopes than most grains. Barley is, however, more susceptible to excess of moisture than oats, but is able to flourish in hot arid regions such as Algeria. Barley is thus found as an associate of rye and oats in lands too cold for wheat ; it flourishes throughout the wheat belts and also in countries too arid for maize and too hot for wheat.

As with wheat, the quality of the grain varies with the climate.

For malting, barley grown in drier and hotter regions ("bright" barley) is preferred. There are two chief types of barley, with six rows and two rows of grain in each head respectively.

World Production.—A map showing the distribution of barley would not differ greatly from that showing the distribution of wheat (Fig. 62), except to emphasize the wider latitudinal range. It is noteworthy, however, that very little barley is grown in the Southern Hemisphere. Fig. 68 shows the fluctuations in recent years in world production. The marked drop was largely due to the disorganization of Russia (producing 8·5 million tons in 1909–13, but only 3·4 million tons in 1924). Canada showed a steadily increasing area and production, but followed recently by a slight decrease; the United States, despite the introduction of prohibition, showed increases in 1928 and 1929, followed by large decreases.

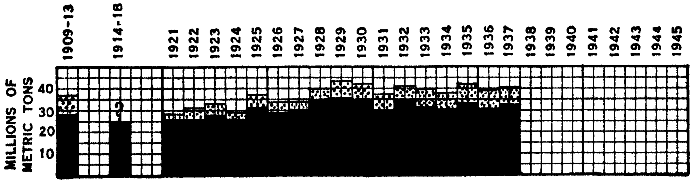

FIG. 68.—World production of barley in recent years.
The dotted portion indicates the Russian production. The world production graphs of wheat, barley, oats, and maize are on the same scale. (To be kept up to date by the student.)

The whole Southern Hemisphere produced, before the war, less than 1 per cent. of the world's total, and the production is now only a little over 3 per cent. Europe normally grows about half the world's total.

That which was said regarding methods of cultivation and yield per acre in relation to wheat is largely true of barley. On the whole the yield is greater than in the case of wheat. A few examples will demonstrate this (1909–13 averages):

Belgium	27·5 quintals per hectare or	44·3 bushels per acre
Great Britain . .	18·5 „ „ „	29·8 „ „
Japan	16·1 „ „ „	25·9 „ „
Canada	15·3 „ „ „	24·6 „ „
U.S.A.	13·1 „ „ „	21·1 „ „
U.S.S.R. . . .	8·7 „ „ „	14·0 „ „

(NOTE.—Multiply quintals per hectare by 1·61 to get bushels per acre.)

World Trade in Barley.—In 1909–13 the average annual export of barley was 5·2 million metric tons—considerably less than one-third of that of wheat and wheat flour. Practically the whole of the export was taken by Europe. In 1921–25 the average annual export was much smaller—due largely to the collapse of the principal exporter (Russia) and the diminished purchasing power of the principal buyer (Germany). This position still holds (Fig. 71).

In pre-war times the bulk of the export trade of the world (in 1909–13 over 70 per cent.) was from Russia, with Rumania, Hungary, India, United States, Austria, and Canada holding the next places as exporters (1909–13). By far the most important importers were Germany (taking 60 per cent. of the total in 1909–13) and Great Britain (20 per cent.), with Belgium, Holland, France, and Norway taking large amounts. Taking present conditions it will be noted :

(*a*) That the trade is very much smaller than formerly ;

(*b*) That a very large proportion of the trade in barley is between European countries ;

(*c*) That the leading importers are the great beer-drinking nations of the world ;

(*d*) That the whole trade suffered greatly from the war.

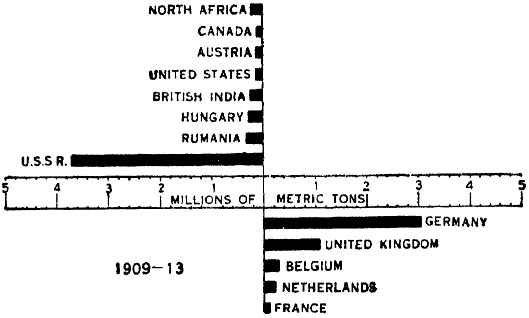

FIG. 69.—The barley trade of the world, 1909–13—principal exporting countries (above) and importing countries (below).

In post-war years the leading exporters have entirely changed. Total exports in 1924 were 2·87 million tons, in 1929 3·16 million tons, and in 1934 2·62 million tons, supplied as follows :

	1924	1929	1934
India	19 per cent.	0 per cent.	0 per cent.
Canada	17 ,,	12 ,,	1·5 ,,
U.S.A.	15 ,,	20 ,,	4 ,,
Rumania	10 ,,	10 ,,	25 ,,
U.S.S.R.	8 ,,	0 ,,	21·5 ,,
Morocco	8 ,,	7 ,,	4 ,,
Argentina	7 ,,	8 ,,	20 ,,
Poland	0 ,,	·8 ,,	6 ,,

In 1924, 1929, and 1934, imports totalled 2·83, 3·55, and 2·81 million tons respectively, absorbed as follows :

	1924	1929	1934
Great Britain	39 per cent.	17 per cent.	33 per cent.
Germany	21 ,,	50 ,,	12 ,,
Holland	10 ,,	9 ,,	29 ,,
Belgium	5 ,,	9 ,,	14·5 ,,
Denmark	5 ,,	1 ,,	2 ,,
France	4 ,,	3 ,,	6 ,,

In 1934 Austria and Switzerland each imported 4 per cent. It will be seen that the disorganization of Russia was the opportunity of Canada, the United States, and Argentina, but that Russia has recently come back as an exporter.

The diagrams, Figs. 69 and 70, further illustrate the position.

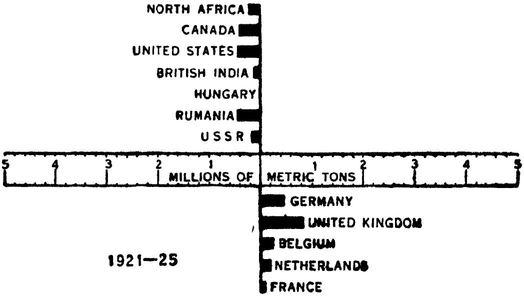

FIG. 70.—Barley trade of the world, 1921-25.

Notice the big diminution in trade and its causes, but notice the later re-appearance of Germany as the main purchaser.

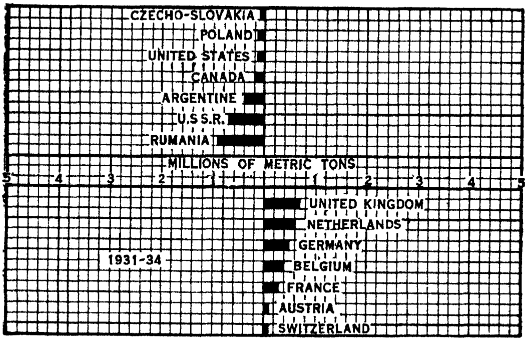

FIG. 71.—Barley trade of the world, 1931-34.

OATS

Oats (*Avena sativa*), like wheat and barley, are obtained from a cultivated grass. Their chief use is as food for cattle and horses. Both the grain and straw are used and in some countries (as in Australia) the immature crop is cut as hay. Oats also form a highly nutritious human food, rich in fats and gluten. The oat cakes made from oatmeal and porridge of Scotland and Scandinavia are particularly well known. The enormous quantity of oats grown is not generally realized; reckoned in bushels oats may form in some years the world's largest cereal crop. But they are grown mainly for home consumption, and so are much less important in world commerce than wheat, barley, or maize.

Conditions of Growth.—Although they can be grown under almost as wide a range of conditions as barley the ideal conditions are damper and cooler than those required for barley or wheat. In the hotter parts of sunny Mediterranean lands oats do not thrive; in tropical and semi-tropical lands like India and China, where both wheat and barley flourish, oats are entirely absent. The zone of maximum production lies in the damper, colder parts of the temperate wheat belt. Oats do not extend quite so far north as barley, but in countries like Newfoundland with a very cool, moist climate, oats grow successfully where no other cereal will do. A remarkable feature is the wide variation in weight per bushel of the grain—from 25 lbs. to 50 lbs., with an average at about 39 lbs.

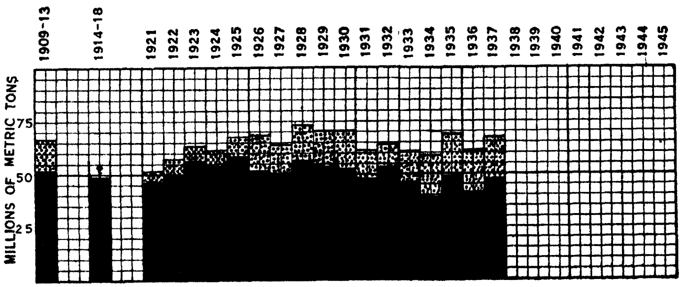

FIG 72.—World production of oats in recent years.
Dotted portion indicates Russian production. (To be kept up to date by the student.)

World Production of Oats.—The area occupied by oats is rather over half that occupied by wheat, and the yield expressed by weight over half. Fig. 72 shows that, if the influence of Russian figures be eliminated, there has been little change in recent years in the area or the yield of oats. Fig. 73, showing the principal oat-growing countries, should be contrasted with the corresponding map for wheat. The distribution of production, expressed as approximate percentages of the total, is illustrated by the following table:

	1909-13	1924	1929	1938
Europe (excluding Russia) .	43	39	42	45
North America	34	47	31	25
Asia (excluding Russia) . .	<0·2	0·3	0·3	0·3
Africa (N. and S.)	0·5	0·4	0.6	0·3
South America	1·3	1·4	1·7	1·5
Australasia	0·8	0·7	0·4	0·1
U.S.S.R.	20	11	23	26

From what has already been said, it is obvious that the yield per acre or hectare will be very different according to whether it is expressed as weight or as measure. By weight it is greater than that of wheat on an average, by measure much greater.

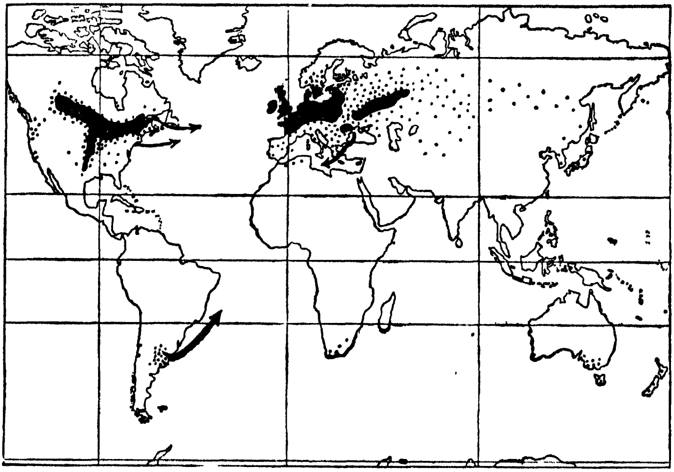

FIG. 73.—Map of the World showing the principal oat-growing countries of the world

Compare this map with the one for wheat, and notice that oats are most important in the cooler parts of the wheat belts; few are grown in the Mediterranean lands and they are absent altogether in such tropical lands as India.

The Principal Oat-growing Countries.—*Russia* is the largest producer and largest exporter in normal times; the oat belt lies along the north of the wheat belt both in Europe and in Asia.

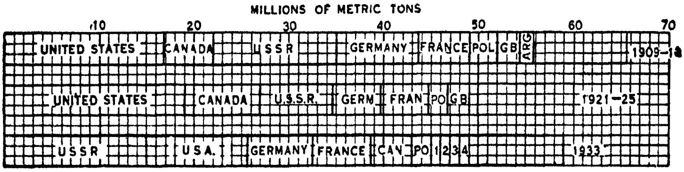

FIG. 74.—Production of oats in principal oat-growing countries.

Compare this with the corresponding diagram for wheat.

Europe.—Oats are extensively grown round the Baltic Sea; in particular, along the south coast of the Baltic Sea poor, sandy soils not good enough for wheat yield excellent crops of oats. Large quantities of oats are grown in Denmark, Holland, and Belgium in connection with the dairying industry. In Great

Britain and France the oat-growing regions embrace most of the wheat lands, but extend northwards and westwards into colder and damper parts. In Southern Europe, even in the continental plains of Hungary and Rumania, production is small.

North America.—The United States, next to Russia, is the world's largest producer. The main oat belt lies rather north and east of the wheat lands from South Dakota and Nebraska through Iowa (one of the leading producers) and eastwards south of the Great Lakes, passing into the Canadian oat lands of Southern Ontario and Southern Quebec. In Canada, Ontario is the largest producer, followed by the prairie provinces, but the great expansion of wheat cultivation has overshadowed that of oats.

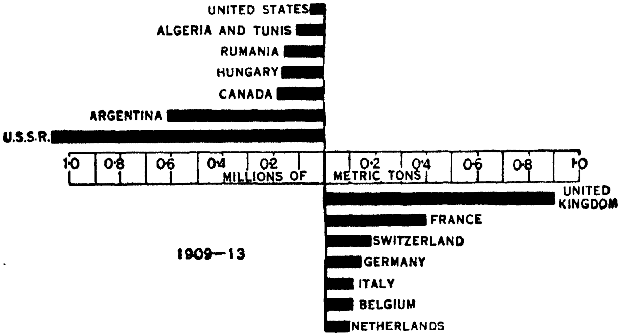

FIG. 75.—World trade in oats, 1909-13—principal exporting countries (above) and importing countries (below).

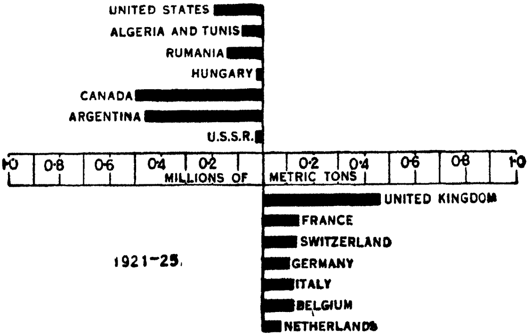

FIG. 76.—World trade in oats, 1921-25.

Southern Hemisphere.—Argentina is the only really important producer.

World Trade in Oats.—Even in normal times only about 4 per cent. of the oat crop crosses an international frontier. In 1909-13

Russia handled over 46 per cent. of the export trade, Argentina 27 per cent., Canada 8 per cent., and the United States 5 per cent. The figure for the United States is partly balanced by an import, reducing it to 2½ per cent. In 1934 Argentina supplied 45 per cent. of the total exports, Canada 13 per cent., and Germany 12 per cent. The total quantity exported averaged 2·3 million tons in 1909–13 (a little over ⅛ of the wheat exported), and 1·5 million tons in 1921–25. In 1931–34 the average was 1·1 million tons.

The leading importer is Great Britain, taking in 1909–13 over 40 per cent. of the total, and in 1934 over 29 per cent. The bulk of the remainder is absorbed by European countries—notably Switzerland, Belgium, Holland, Austria, and Denmark (for the dairying industry); Italy, Sweden, and France normally take large quantities. It is interesting to note that in certain recent years (*e.g.* 1924) the United States figures on the balance as an importer, but in 1931–34 has exported an average of 270,000 tons.

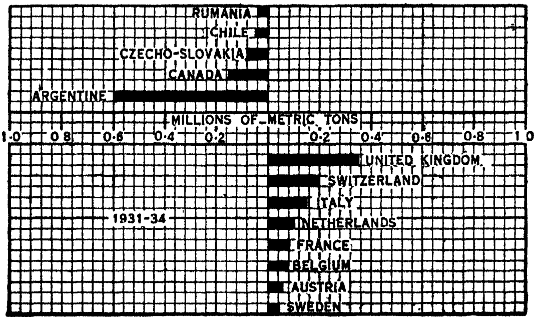

FIG. 77.—World trade in oats, 1931–34.

RYE

Rye is a cereal closely resembling barley in appearance. Unfamiliar in the great wheat-growing countries, it is difficult to appreciate the enormous importance of rye over a large part of Europe. Rye bread is the staple food of the peasantry of half Europe—of nearly all that portion lying east of the Rhine and north of the Alpine mountain system. The bread is dark in colour and somewhat heavy and sour, but very nutritious, whilst various alcoholic liquors such as vodka and rye whisky are also prepared from the grain.

Conditions of Growth.—Rye is usually grown on poor soils and in cool climates where wheat fails, though the optimum conditions for its cultivation correspond closely with those of wheat.

in particular the marshy and sandy tracts of the great European plain, the bleak uplands of the Central Plateau in France, may be cited as regions which owe much to the hardiness of the rye plant. Rye straw is stronger than wheat straw, and in the United States is used in making pasteboard and paper.

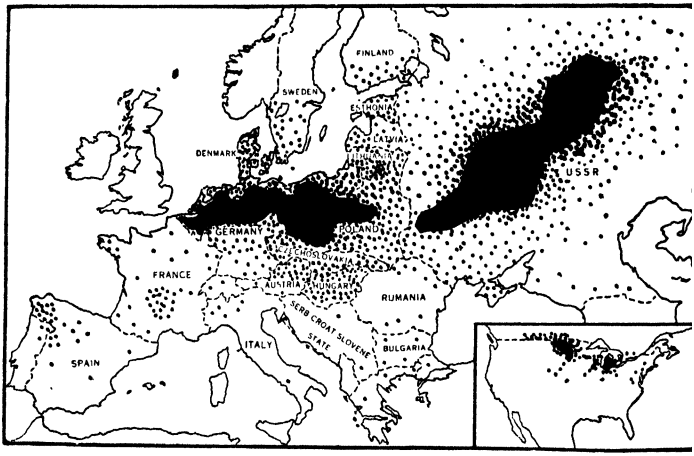
FINLAND
SWEDEN
ESTHONIA
LATVIA
LITHUANIA
DENMARK
USSR
GERMANY
POLAND
CZECHOSLOVAKIA
FRANCE
AUSTRIA
HUNGARY
RUMANIA
SERB CROAT SLOVENE STATE
ITALY
BULGARIA
SPAIN

Fig. 78.—Map showing the principal rye-growing countries of the world. (Adapted from the *Chambers of Commerce Atlas.*)

World Production of Rye and the Chief Rye-growing Countries.—The world production of rye averaged 45 million metric tons in 1909–13, thus actually approaching half the total for wheat. In post-war years the proportion is slightly less.

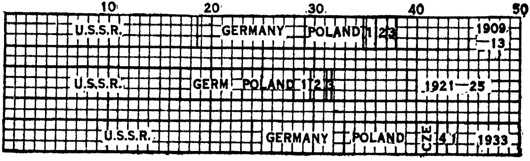

Fig. 79.—Production of rye in the principal rye-growing countries.

Over 97 per cent. is grown and consumed in Europe and Asiatic Russia. The only important producers outside Europe are the United States and Canada, where the cultivation of rye has been considerably influenced by immigration of peasants from the great rye-growing countries of Europe.

World Trade in Rye.—Rye is almost entirely grown for home consumption and such trade as exists is largely between the countries of North-Eastern Europe. For some years after the war, however, more than half the total crop of the United States was exported, but recently exports have been nil, and there was an import in 1934. The chief exporters are Poland, Russia, Germany, and Hungary. The importing countries are Belgium, Norway, Denmark, Holland, and Finland. The total quantity entering into foreign trade, including rye flour, in 1909–13 was about 1·4 million tons, and in 1934 1·3 million tons. The increase in trade after the war was due to America's increased export (1·1 million tons in 1924) and to the readjustment of east European frontiers.

RICE

Rice (*Oriza sativa*), like the temperate grains already considered, is a member of the order Gramineæ. It is the staple food grain of the densely populated wetter parts of South-Eastern Asia--India, Indo-China, China, Japan, and the East Indies—and is also an important crop in other tropical and subtropical regions. Although considered botanically as a single species, there are many hundred varieties of rice, differing in the colour, size, and shape of the grain, in the height of the stalks and in the climatic and edaphic requirements of the plant. The existence of these numerous varieties is largely due to the isolation of many of the areas where cultivation is carried on (*e.g.* the river valleys of Indo-China and the interior basins of China), to the conservatism and ignorance of the native cultivators who go on growing a particular, often inferior, variety, merely because their forefathers did before them. The varieties fall into two main classes, of which the second is by far the most important:

(1) Upland or hill rice (which can be grown on hill slopes).

(2) Lowland or swamp rice (which requires level, flooded fields).

By far the largest proportion of the crop is grown for local consumption; for that portion intended for export a trade classification and trade names are in use.

Rice in the husk is known as paddy (occasionally written padi); indeed, in Eastern lands the word rice is little used and one invariably refers to paddy fields and paddy cultivation. The polished rice so familiar in Western lands is never seen in the East, where the rice is merely husked and skinned.

Conditions of Growth.—The grain is sown under water and for the first few weeks of its existence the young rice plant grows under standing water. As the time of ripening approaches, gradually less and less water is required. It follows that the essentials for paddy cultivation include:

(1) Flat fields which can be flooded and which have either an impervious soil or an impervious layer a short distance below the surface soil.

(2) An abundant supply of water during the growing season. If the supply of water depends entirely on rainfall a minimum fall of 40 inches a year is necessary. The "safety" average may be as high as 80 inches. Generally speaking in India and Indo-China rice is practically the only good crop where the rainfall is above 80 inches and is widely grown with a rainfall of between 40 and 80 inches. With a smaller rainfall its place is taken by millets or wheat and barley.

The great river deltas and alluvial plains form ideal rice-lands. In hilly country the hill slopes must be carefully terraced before the necessary flat fields are obtained. Particularly in the hilly districts of Ceylon and Java remarkable examples of hill terracing may be seen. The attached diagram represents a section, to true scale, of a terraced hill-side. The individual field may be only 2 or 3 feet wide. Whether in hilly or flat country, native cultivators choose one small field as a "nursery," from which the tiny plants when about 6 inches high are transplanted, by hand, in small bundles in rows in the flooded fields. The labour involved is obviously enormous, more especially when one remembers that the ploughing is done by a small wooden plough drawn by a couple of slow-moving oxen or water buffaloes. Reaping is also by hand. The growth of the rice plant when flooded is extraordinarily rapid—even 6 or 9 inches in 24 hours—and given great heat ripening is so rapid that as many as five crops from one area in a single year have been obtained. Two crops a year are usual in many parts of the East, whilst in cooler regions rice forms a summer crop, wheat or another cereal a winter crop. For ripening, a brief spell of 80° or nearly

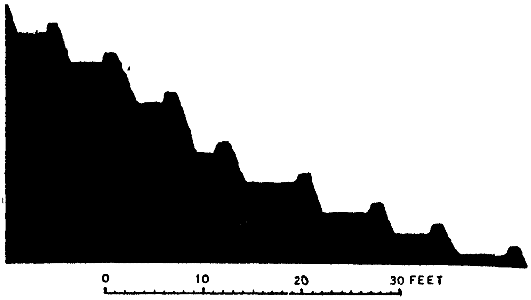

FIG. 80.—Section through a steep hillside, drawn to true scale, showing the method of terracing for tiny rice-fields.

Examples of slopes as steep as this are common in Java and Ceylon.

that temperature is required, and the July isotherm of 75° marks approximately the northern limit in the Northern Hemisphere and the January isotherm of 75° the southern limit in the Southern Hemisphere.

World Production of Rice.—It is difficult to estimate the world production of rice, owing to the absence of statistics for the leading country—China. The total is probably roughly the same as that of wheat. Probably a quarter of the world's inhabitants are rice-eaters. Fig. 81 shows the great rice-growing countries. By far the larger part of the crop—over 95 per cent.—is grown for home consumption and the world trade in rice is small in proportion to the quantity grown. Over 95 per cent. of the world's rice is grown in Asia.

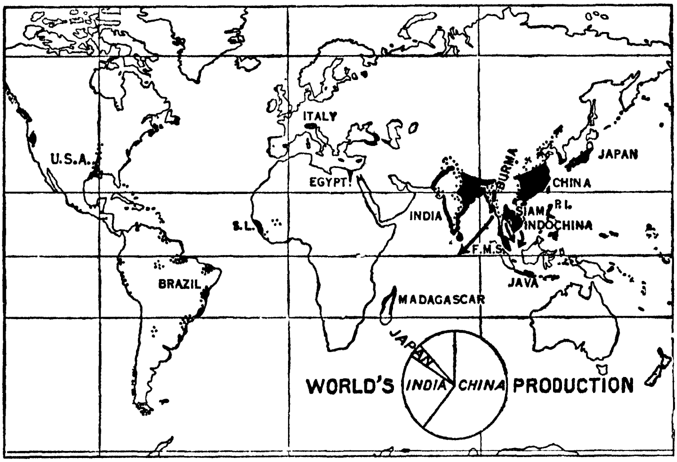

FIG. 81.—Map of the World showing the principal rice-growing countries.

Rice shows a higher yield than any other cereal. The world average (1930–34) was 19·8 quintals per hectare (excluding China). Spain, Italy, Japan, and Egypt all had averages of over 30 quintals.

The Principal Rice-growing Countries.—*India.*—Notwithstanding the huge quantity of rice grown in India, it is a great mistake to consider rice as the staple food throughout India. In those regions with a rainfall of less than 40 inches (about half of the whole of India) it is relatively unimportant and over huge tracts is actually unknown. Nearly the whole of India's rice—over 40 million tons per annum—is consumed at home, and in many years there is a considerable import. The bulk of the export, which in statistical returns is ascribed to India, comes from Burma, which, though a province of the Indian Empire, is geographically a part of

Indo-China. In India the rice is grown mainly in the valley and deltas of the Ganges and Brahmaputra and the alluvial coastlands; in Burma the delta of the Irrawaddy is the main area. Rangoon handles most of the export.

Indo-China.—The delta of the Mekong in French Indo-China grows rice in excess of local requirements, and the surplus is exported mainly through Saigon. Siam likewise exports rice through Bangkok from its fertile alluvial plains.

China.—Rice is universally grown in Southern and most of Central China, but the surplus available for export is practically nil.

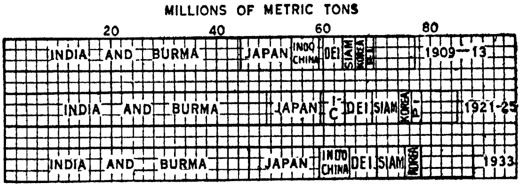

FIG. 82.—Production of rice in the principal rice-growing countries.

Only a rough estimate is available of the enormous production—entirely for home consumption—in China. Relative to the huge quantity grown in India and the Far East, the production of the various non-Asiatic countries shown on Fig. 81 is too slight to be indicated in detail.

Japan.—Although rice is the leading cereal crop of Japan only the southern two-thirds of the empire are sufficiently warm for its growth. Japan now draws large supplies from Korea.

The East Indies.—Rice is the staple cereal crop; Java, despite a huge production, is not self-supporting.

Europe.—The only countries in Europe where rice is an important crop are Italy and Spain. Italy has extensive rice lands in the valley of the Po, and the cultivation depends as much on the supply of cheap agricultural labour as on the suitability of the climate. Spain has ricefields on the coastal lowlands around Valencia on the east coast.

Africa.—Egypt and Madagascar are large producers, and rice has recently become important on the west coast—notably in Sierra Leone.

North America.—There are three areas of cultivation in the United States; the Gulf coastal plains, the Lower Mississippi Valley, and part of the Sacramento Valley in California. A pre-war deficit made good by imports has now been changed to a surplus.

South America.—Rice is grown in various parts of the coast tracts of Brazil, Guiana, Colombia, Ecuador, and Peru.

World Trade in Rice.—The world trade in rice may be considered as being of two types. There is the semi-local trade between the great rice-eating countries of the East, whereby one area with a surplus makes up the deficiencies of another with a deficit. This trade may vary greatly from year to year according to the harvests. Thus Burma's surplus may sometimes go mainly to India, sometimes largely to Ceylon, Java, or even China. Only three areas have regularly a large surplus. These are Burma, Siam, and French Indo-China. There is always a large import, necessary for existence, into Ceylon, Malaya (Malay States and Straits Settlements), Java, and Japan. Of recent years the largest importer of all has been China.

In the second place, there is the trade between Europe and the East. All the countries of Europe (except Spain and Italy which have a small surplus), nearly all the countries of North and South America (except the United States and Brazil), nearly all Africa (except Egypt, Madagascar, and parts of West Africa), and all parts of Australasia regularly import small quantities of rice. The supply is maintained by Burma (and to a very small extent India proper), Siam, French Indo-China, and, of recent years, the United States.

The average export of rice in 1909–13 was 4·4 million tons (2·4 from India and Burma; 0·9 from Indo-China; 0·8 from Siam); in 1929, 6·2 million tons (2·1 from India and Burma; 1·3 from Indo-China; 1·0 from Siam; 0·14 from U.S.A.); in 1934, 5·3 million tons (1·4 from India and Burma; 1·3 from Indo-China; 1·1 from Siam; 0·4 from U.S.A.). Of the total export between half and two-thirds enters into local inter-Asiatic trade only, but no less than 1·6 million tons went to Italy in 1934.

CORN OR MAIZE

Maize (*Zea maïs*) is a native of the New World and was introduced into Europe by Columbus. Its origin is indicated in the common English name, "Indian Corn," whilst the simple American term, "corn," indicates its pre-eminent importance as a cereal in the United States. Corn, though another member of the Gramineæ, differs greatly from the cereals already considered. Its great, strong stalks commonly grow to a height of 6 feet and may reach 18 feet; bearing at the top the feathery male flowers, whilst the female flowers, which later develop into the cob, lie hidden in their sheath lower down between one of the leaves and the stem. The corn grains when ground with their skins form maize meal (England), mush (America), or mealie meal (South Africa); the fine white flour made by grinding the grains divested of their skins is called corn-flour.

Maize does not make good bread, but in various forms it is an important human food in many parts of the world. In the United States it is eaten as "hominy" and "pone," and the unripe corn is a favourite vegetable. In Mexico, South Africa, most of Italy, and various parts of South-East Europe and parts of North India, it is ground into meal and forms the staple food of the people. Its principal use, however, is as food for cattle, for which purpose it is unequalled. The grain, meal, and the young, juicy plants are all used as cattle food.

Conditions of Growth.—To grow well, maize requires a good soil. Well-drained loams, deep and rich in plant foods, are the best. Deep ploughing is also essential.

Maize is essentially a summer crop and requires frequent summer rains (or irrigation) during the growing period, but the soil must never become sodden. During the life of the plant, from 4½ to 7 months, there must be no great variations in temperature; frost is fatal, the middle portion should be hot both day and night, and there must be plenty of sunshine. Thus maize cannot be grown unless half the year is free from frost, nor will it ripen in lands like England where the summers are too cool. Low rainfall is another limiting factor.

The World Production of Maize.—Fig. 84 shows at a glance the principal maize-growing countries and emphasizes the overwhelming importance of the United States in world production—with over 70 per cent. of the world's total. Fig. 83 shows that the annual fluctuations in production reflect to a considerable extent the American harvest. The yield of maize is usually higher than the

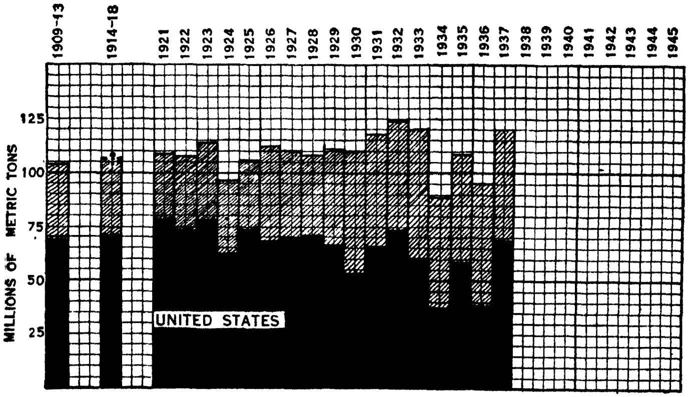

FIG. 83.—World production of maize in recent years.

The portion in black relates to the United States only. The graph illustrates the way in which world production fluctuates with that of the United States.

other cereals (except rice); the 1930–34 average for the world was 16·8 quintals per hectare (U.S.A. 14·9).

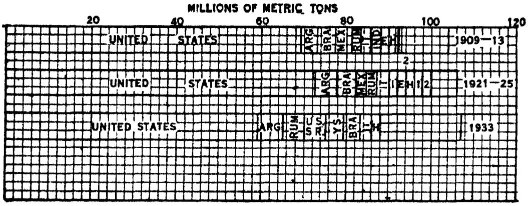

FIG. 84.—Production of maize in the principal maize-growing countries.

The Principal Maize-growing Countries.—*The United States.*—The maize belt in North America lies, generally speaking, south of the wheat belt and north of the cotton belt. The area of greatest production stretches from Eastern Nebraska, through Iowa, Illinois, and Indiana to Ohio. South of this main area, maize is grown throughout the cotton belt to the shores of the Gulf of Mexico and the Atlantic. The western limit is the summer rainfall line of 8 inches; the northern limit the mean summer isotherm of 66°. The enormous importance of the crop may be gauged from the fact that it occupies nearly half the land devoted to cereals in the United States, and over twice the area occupied by wheat (1934). Nevertheless it is nearly all grown for home consumption, and in 1934 less than 4 per cent. of the crop was exported. It makes

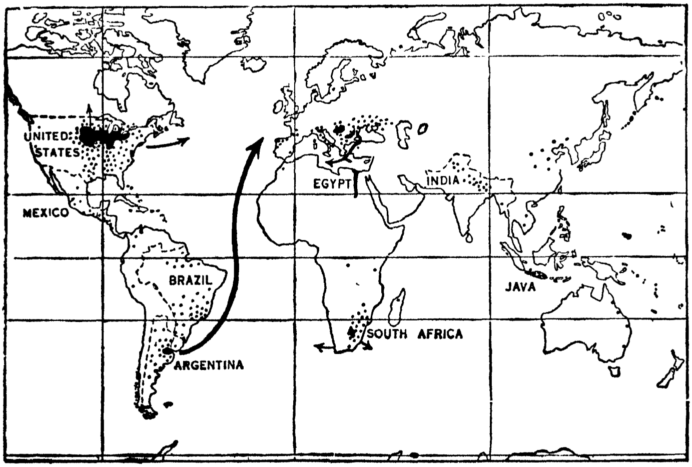

FIG. 85.—Map of the World showing the principal maize-growing countries. The arrows indicate the direction of the export trade.

possible the great cattle and pig-rearing industries which find their foci in the maize belt.

Canada.—A little maize is grown in southern Ontario, but nearly the whole of Canada lies too far north.

Mexico.—Maize is the leading cereal crop and is largely used for human food.

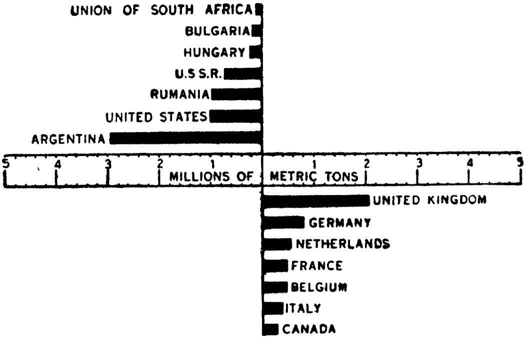

FIG 86.—World trade in maize, 1909–13—principal exporting countries (above) and importing countries (below).

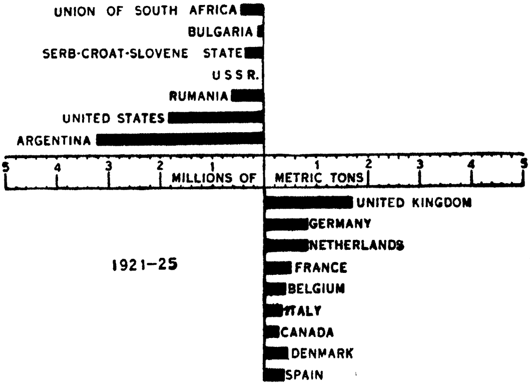

FIG. 87.—World trade in maize, 1921–25.

Argentina and *Brazil* now take second and sixth place as world producers, and a large surplus is available for export.

Europe.—The great maize-growing areas of Europe lie in the south-east. Rumania, Yugoslavia, Italy, and Hungary are the leading producers, the first two vying with Argentina in total production. Large quantities are, in normal times, grown in Russia. In the moister regions of Spain and Southern France it is also an important crop, but in England and Northern Europe is only grown as green fodder, the summer temperatures being insufficient to ripen the grain.

Africa.—Maize is the leading cereal of the Union of South Africa and Southern Rhodesia (see the section on South Africa in Part II) and also in Egypt. There are great possibilities for extension of maize cultivation in both East and West Africa.

Asia.—Large crops are grown in the Gangetic Plain of Northern India—not as the leading crop, but together with rice or wheat—Northern and Central China, and in Java.

Australia.—The east coasts of Queensland and New South Wales are suitable and there is a small production.

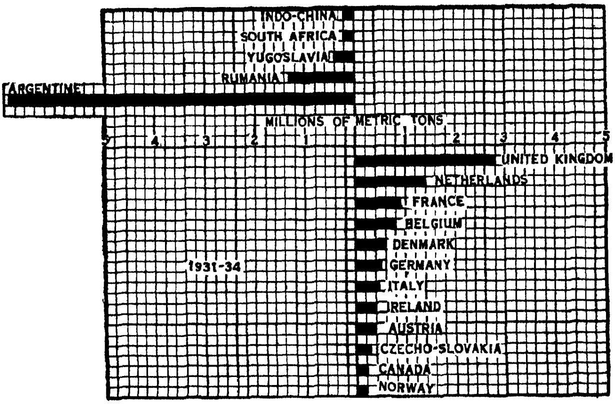

Fig. 88.—World trade in maize, 1931–34.

World Trade in Maize.—The average export of maize in 1909–13 was 6·3 million metric tons, and in 1921–25 was 6·9 million metric tons. In 1926–29 it averaged 8·8, in 1931–34 9·6.

In 1909–13 nearly half the total was supplied by the Argentine Republic, and in 1921–25 more than half; in 1934 three-quarters. In 1909–13 the leading exporters were: Argentina, 2·9; U.S.A., 1·1; Rumania, 1·0; Russia, 0·8; Hungary, 0·3; Bulgaria, 0·2; and South Africa, 0·1. In 1931–34 the exporters were: Argentina, 6·9; U.S.A., 0·1 (compare 4·2 in 1922); Rumania, 1·1; Union of South Africa, 0·2; Yugoslavia, 0·4. The trade is mainly with European countries. Great Britain takes about a third of the total and all the North European countries share in the trade. Outside Europe a notable importer is Canada, who, before the war, took between a quarter and a third of the U.S.A. surplus.

MILLETS

None of the millets enters widely into international commerce, but as a whole they are so important as forming the staple food of the inhabitants of many of the drier parts of tropical and subtropical lands that a map has been included showing their general distribution. They are especially important in India (for which see the section on India in Part II).

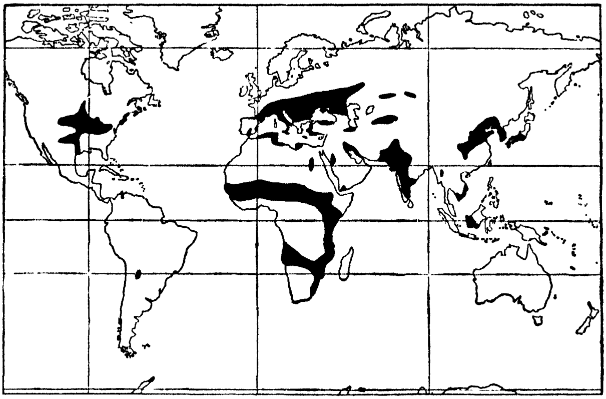

FIG. 89.—Map of the World showing the principal millet-growing areas. The map is generalized; actually millet growing is restricted to certain parts only of the belts marked in black.

OTHER GRAINS AND FOODSTUFFS

Buckwheat, unlike other grains, is not obtained from a grass but from a lowly herb. It is nutritious, can be grown on very poor soils in temperate latitudes and matures rapidly so that it can be planted if another crop has failed. **Quinoa** is a small food grain widely used on the high plateaus of South America where the variety of plants which can be grown is very limited. **Pulses** are the various members of the pea and bean tribe—most important are peas, chick-peas (the grain of India), lentils, beans and soya-beans (a staple food in China, Manchuria and Japan).

Yams are large tubers, up to 50 lbs. in weight, which provide the main food of many groups of African natives in the wetter regions. **Potatoes** and **sweet potatoes** are similarly tubers, the former now almost universal. **Cassava** (or manioc) is important in tropical Africa and South America and a preparation from the same tuberous roots forms *tapioca*. **Sago** is prepared from the pith of the sago palm; true arrowroot from the root of a plant especially important in the West Indian island of St. Vincent.

EXERCISES

1. By reference to the *Year Book of the International Agricultural Institute* complete the tables in this chapter by inserting figures for the last year of which statistics are available.

2. Similarly complete Figs. 63, 64, 68, 72, 74, 79, 82, 83, 84.

3. Similarly complete Figs. 67, 71, 77, and 88 (trade).

4. Show production of one of the cereals in the form of a "wheel diagram," that is, let a complete circle of 360° represent total production; a segment of 60° will represent a country producing one-sixth of the world's total, and so on. (There is a simple wheel diagram on Fig. 81.)

EXAMINATION QUESTIONS

1. Describe the factors affecting supply and demand of the world's wheat. (*Univ. Toronto, 1st Year Pass,* 1925.)

2. Discuss the geographic features essential to the optima of plant life and show the relation of your answer to the problem of increasing the world's food supply. (*Univ. Toronto, 1st Year Hons.,* 1926.)

3. (*a*) Discuss the relative advantages of Russia and Canada with respect to routes and to cost of transportation of wheat to world markets.

(*b*) Name the four chief factors which determine the location of flour-milling centres. Choose two important centres of the industry in Canada and show which factors have played a large part in developing the industry at each point. (*Prov. Alberta Matric.,* 1927.)

4. Describe carefully the conditions necessary for the growth of three important food grains of the world, and give a brief account of their distribution. (*Univ. Rangoon Inter.,* 1926.)

5. Account for the general distribution of the maize crop in North America (*Univ. of London Inter. B. Com*, 1921)

6 Discuss the value of a mean annual rainfall map as an index to the possibility of wheat cultivation (*Univ London Inter B Com.,* 1921.)

7. Describe and explain, as far as you are able, the conditions that accompany the production of rice as a staple food of a people (*Univ. London Inter. B.Sc.* (*Econ.*), 1925).

8 In the case of the wheat plant give instances of the methods by which cultivation has been extended into regions the climates of which, some decades ago, would have been considered unsuitable. (*Univ. London Inter. B. Com*, 1922)

9. Give a brief account of the world trade in wheat, noting the principal exporting and importing countries, with ports of shipment and import. (*Univ. London Inter. B. Com*, 1929)

10. Describe in detail the annual sequence of farming operations in a rice growing country. Correlate variations from the sequence described with different climatic conditions. (*Univ. London Inter. B. Com.,* 1930.)

11. With the help of sketch maps and diagrams describe the present world trade in wheat. (*Univ. London Higher Schools E,* 1932.)

12. Describe the geographical conditions found in the chief wheat-growing areas of *either* North America *or* Europe. (*Univ. London Inter. B.Sc.* (*Econ.*), 1932.)

13. Discuss the geographical conditions necessary for the large-scale production of wheat. Briefly examine these conditions as exemplified in two well-contrasted producing areas. (*Univ. London Inter. B.Sc.* (*Econ.*), 1934.)

14. Describe and account for the distribution of rice cultivation in India *or* China *or* Japan. (*Univ. London Inter. B.Sc.* (*Econ.*), 1934.)

CHAPTER VII

OTHER VEGETABLE FOODSTUFFS

Whilst cereals constitute the most important food of mankind, numerous other substances of vegetable origin enter into his diet or provide him with drink, or help to ameliorate the troubles of life by providing him with pleasant narcotics such as tobacco, or with medicines. Only the more important of the wide range of vegetable substances will here be considered.

SUGAR

Unknown to the peoples of the ancient world, sugar has become practically a necessity of life in most parts of the world. Sugar is obtained mainly from two sources. *Cane-sugar* is prepared from the juice of the sugar-cane; *beet-sugar* from the root of the sugar-beet, which was only discovered towards the end of the eighteenth century. The sugar-cane is essentially a tropical or subtropical plant; the sugar-beet essentially a temperate plant.

CANE-SUGAR

The sugar-cane (*Saccharum officinarum*) is a thick-stemmed grass, not unlike maize in general appearance, growing to a height of 8–12 feet. The stalks are cut annually, but the roots are allowed to give out new shoots usually for five years. The canes are crushed by being run through rollers at the mills, the latter being situated near the plantations. The juice is thickened by boiling, lime, which combines with the impurities, being added to clarify it. Crystalline "raw sugar" is then allowed to separate out, the residual thick syrup forming "molasses." The refining of raw sugar is usually carried out in the countries of consumption, treacle and golden syrup being by-products.

Conditions of Growth.—The sugar-cane requires a rich soil and a hot, moist climate. Though not essential, sugar-cane seems to benefit from sea breezes, and most of the great cane-growing regions are not far removed from the sea. It will be found that all the great sugar-producing regions have an annual rainfall of over 40 inches (unless irrigated), a freedom from frost practically throughout the year, a high humidity, and a temperature of 80° or over in the warmest month. But too much moisture gives a juice poor in sugar. The cane is cut by hand and manual work in such hot, humid atmospheres is unsuited to the white man, with the result that a supply of native labour is an essential.

World Production of Cane-Sugar.—Before the war cane-sugar suffered severely from the competition of beet, and in 1913 roughly equal amounts of the two kinds were produced. The beet-growing countries were the ones most severely affected by the war, with the result that cane-sugar has benefited. This is illustrated by the graph, Fig. 90. In 1923–26, and again in 1927–30, the quantity of cane-sugar produced was roughly double that of beet-sugar.

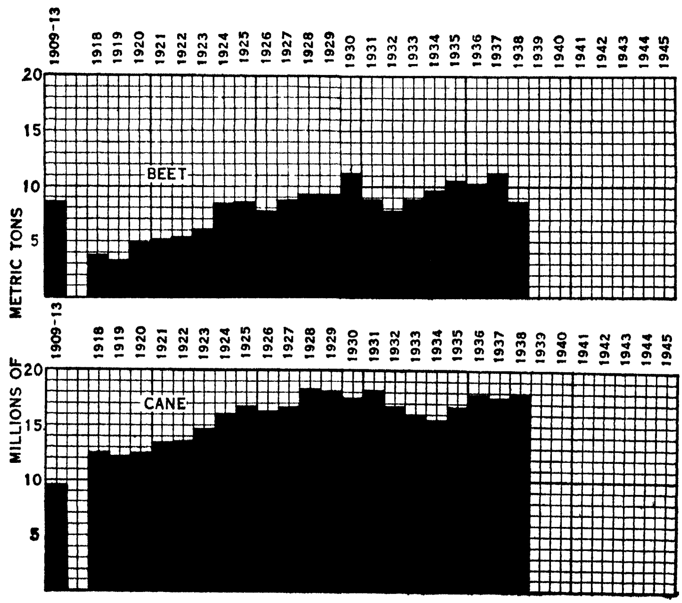

FIG. 90.—World production of cane and beet sugar.
Notice the tremendous drop in the production of beet sugar caused by the War, and the steady rise in cane sugar which followed, succeeded later by a drop.

Each hectare of plantation produces from 25 to 132 tons of cane (Cuba 41·3 in 1929–32; Java 131·6 in 1929–32). Efficiency in extraction varies greatly; the best results being obtained from large, well-equipped mills fed with cane from numerous plantations. In Cuba and Java 8½–11 tons of cane produce 1 ton of raw sugar.

Sugar-Cane-growing Countries.—Fig. 91 shows the leading sugar-producing countries of the world. Given adequate climatic conditions, the large-scale production of cane-sugar is determined mainly by labour conditions. Fig. 92 shows the leading producers.

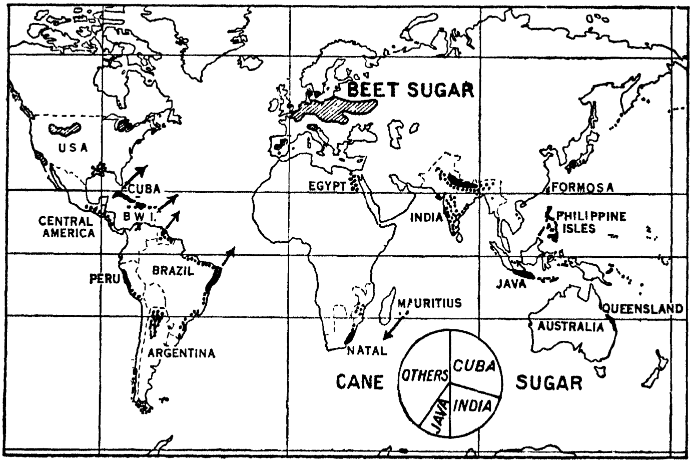
BEET SUGAR
USA
CUBA
CENTRAL AMERICA
B W I.
PERU
BRAZIL
ARGENTINA
EGYPT
INDIA
MAURITIUS
NATAL
FORMOSA
PHILIPPINE ISLES
JAVA
QUEENSLAND
AUSTRALIA
CANE
SUGAR
OTHERS
CUBA
INDIA
JAVA

FIG. 91.—Map of the World showing the principal sugar-producing countries.

The West Indies.—Ideal conditions are found in Cuba and many of the West Indian islands. The greater part of the labour is negro labour—descendants of African slaves. The normal prosperity of the Cuban industry is shared by Porto Rico and Dominica, and is mainly the result of American enterprise. The British West Indian islands produce very large crops in proportion to their size; sugar is often the leading crop and the prosperity of these islands (notably Barbados, Antigua, Trinidad and Tobago, Jamaica and the Windward Islands) has suffered from the competition of beet.

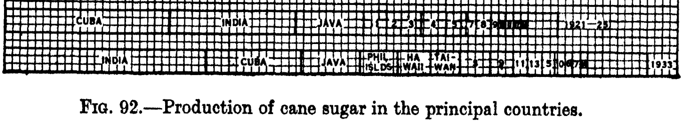

FIG. 92.—Production of cane sugar in the principal countries.

Key (with 1921–25 approximate productions in millions of tons).—1 = Hawaii (0·6); 2 = Philippine Isles (0·47); 3 = Porto Rico (0·45); 4 = Brazil (0·8); 5 = Argentina (0·26); 6 = U.S.A. (Louisiana) (0·18); 7 = Mauritius (0·23); 8 = Formosa (0·43); 9 = Australia (0·38); 10 = Natal (0·17); 11 = Dominica (0·25); 12 = B.W.I. (0·2); 13 = Peru (0·3); 14 = Mexico

North and Central America.—Louisiana, round the Mississippi delta, is the sugar-growing state of the United States; Mexico and the Central American countries have a considerable production.

South America.—The home of "Demarara" sugar is in British Guiana; Brazil and Peru have large productions on their coastal regions, and there is a considerable output from Northern Argentine —in an inland situation.

Africa.—The coastal strip of Natal and Zululand produces sufficient sugar to supply South Africa, and there is a considerable production in Egypt. Most of the other cane-sugar attributed to Africa is grown in the islands of Mauritius (British) and Reunion (French).

Asia.—India leads Cuba as the first producer, and has recently developed the sugar industry to satisfy the home demand instead of importing from Java. Japan utilizes her tropical possession, Formosa, in the same way as the United States uses the Hawaiian Islands, the Philippines, and Cuba.

Oceania.—The production of cane-sugar on the coastal strip of Queensland is bound up with the labour question and is difficult under the "White Australia" policy (see section on Australia). The production in Hawaii has already been noted; that in Fiji is also important.

World Trade in Cane-Sugar.—With the exception of India and the South American Republics, nearly all the great producing areas are small islands growing sugar essentially for export. It is interesting to note that the great importing countries draw their supplies from different sources. The United States naturally draws the bulk from Cuba, Porto Rico, Dominica, and Hawaii; Great Britain from Cuba, Java, her West Indian possessions, Mauritius, and British Guiana; India from Java. The beet-growing countries of the continent of Europe are to a considerable extent independent of cane-sugar.

BEET-SUGAR

The sugar-beet is an annual plant, raised from seed sown in the spring. The whitish, turnip-like roots are ready for digging in the autumn. The roots are washed, before being sliced for the expression of the juice. The residue is a nutritious cattle food.

Conditions of Growth.—Sugar-beet is an exhausting crop, and requires well-drained, fertile, loamy soils. Shallow or stony soils prevent the proper development of the root. A certain proportion of lime is essential, and plant-food must be renewed in the soil from year to year by manuring. The crushed pulp, applied either direct or as offal from the cattle fed on it, makes excellent manure. The sugar-beet is essentially a temperate crop. The sugar content depends upon adequate moisture during growth, and the summer temperature. Optimum conditions are said to exist with a temperature between 60° F. and 73° F. for three months of the summer. Again a plentiful supply of labour is needed, but the climatic conditions are those suited to white labour.

World Production of Beet-Sugar.—Under various forms of Government encouragement sugar-beet became one of the leading crops of the continent of Europe, until in 1913 the world production of beet-sugar equalled that of cane. The effect of the war has already been noted (see Fig. 90).

Each hectare of sugar-beet produces (1928–32 world average) 17 tons of the beet. In Holland the average was over 36 tons. It will be noted that the yields of raw material are much lower than in the case of sugar-cane. In the early days of the industry it required as much as 30 tons of beet to produce 1 ton of raw sugar, but careful selection and cultivation have resulted in an average world yield (1925–29) of 1 ton of raw sugar from 6½ tons of beet, so that the sugar-beet is now actually richer in sugar than the sugar-cane.

Sugar-Beet-growing Countries.—Large scale production of beet-sugar is practically restricted to the continent of Europe and the United States. In the United States the labour difficulty is a rious one. In 1909–13 the leading producers were Germany, Russia, Austria, France, Poland, Hungary, Holland, Belgium, and Italy. Recent figures show Germany and U.S.S.R. as rivals for the first position, followed by U.S.A., France, Czechoslovakia, Poland, and the countries enumerated above. Important progress has been made in the last few years with the cultivation of sugar-beet in England.

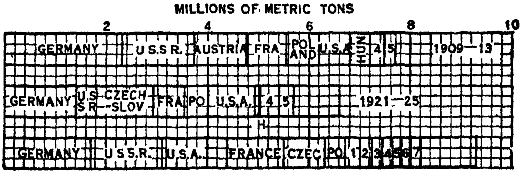

FIG. 93.—Production of beet-sugar in the principal countries.

NOTE—In the 1909–13 diagram "Austria" refers to pre-war boundaries, Poland and U.S.S.R. to present boundaries.

World Trade in Beet-Sugar.—Before the Great War, Germany, Austria-Hungary, Denmark, and Holland were large exporters, and supplied Great Britain with nearly two-thirds of her sugar. In 1913, Germany alone supplied nearly half a million tons—more than all the cane-sugar used in England. In 1934, the total imports of sugar into Great Britain were over two million tons.

TEA

The tea of commerce is obtained by drying the leaves of a small evergreen shrub, *Thea camellia*, a native of South-Eastern Asia. Although no longer a monopoly of China as it was a century ago, the bulk of the world's tea is produced in the Monsoon lands of South-Eastern Asia. Tea-drinking has become general with all the English-speaking white races, and in Holland and Japan.

Conditions of Growth.—The tea shrub requires a deep, fertile soil very well drained, as stagnant water in the soil is particularly harmful. Soils from recently cleared forest land on hillsides are excellent, but provided the drainage is good, tea grows well on valley lands (as in Assam). The tea shrub may be classed as a subtropical plant, but is a very hardy plant and, provided the growing season is long, warm, and moist, is not injured by winter frost. Left to itself it grows to the size of a small tree, but when grown for tea it is pruned every year in the spring to form a bush 3 or 4 feet high. Some weeks after pruning young shoots appear, and when the leaves reach a certain size they are picked. Another crop of leaves (another " flush ") occurs later, and others at intervals of a week or ten days during the season. There are three or four pickings in China, sixteen in Assam, and even more in Ceylon during the season. An abundance of cheap native labour is essential for the picking of the leaves at the moment they are ready. The various flushes afford tea of differing quality. After gathering, the leaves are withered (by being spread out on wire trays and dried), rolled, partly fermented, dried, and sifted. " Green " teas are merely dried over charcoal fires.

World Production and Trade.—There are five great producing areas—China, Assam, Ceylon and South India, Java, and Japan. All these are densely populated countries where an adequate labour supply is available. Successful experiments in tea-growing have been made in many parts of the world—Natal, Jamaica, Brazil, and California, but the production, owing to shortage of labour, remains negligible. Fig. 94 shows the world production in recent years, and the proportions produced by the various countries.

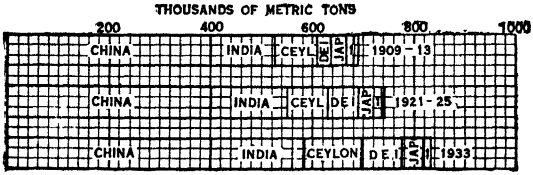

FIG. 94.—Production of tea in the principal countries.

The amount shown for China is a rough estimate only. 1 = Formosa or Taiwan. Notice the very small proportion allotted to " other producers."

China.—The great tea-growing areas of China are in the Yangtze Kiang valley and amongst the hills of the south-east. Until about 1850 this area supplied the entire commercial crop of the world. Since then the importance of tea amongst the exports of China has steadily dropped.

India.—A resolve to attempt tea planting in Assam nearly a century ago resulted in the discovery of the tea bush growing wild, and Assam is believed by many to be its original home. Assamese supplies commenced to be important about 1850, and Assam now supplies nearly half the world's export. The plantations are situated on the hilly slopes on either side of the Brahmaputra Valley and, of recent years, have extended in the valley itself. They stretch westwards into Northern Bengal around Darjeeling, and another important area is on the southern slopes of the Garo and Khasi Hills in Assam. All these are areas with a very heavy rainfall, and in general a warm, damp climate. The other tea-growing area of India is in the extreme south, amongst the Nilgiri Hills of Madras and the hills of Travancore. The delicately flavoured, aromatic "China" teas contrast with the stronger flavoured, black, Indian teas, but it should be noted that "China" teas can be, and are, grown in India.

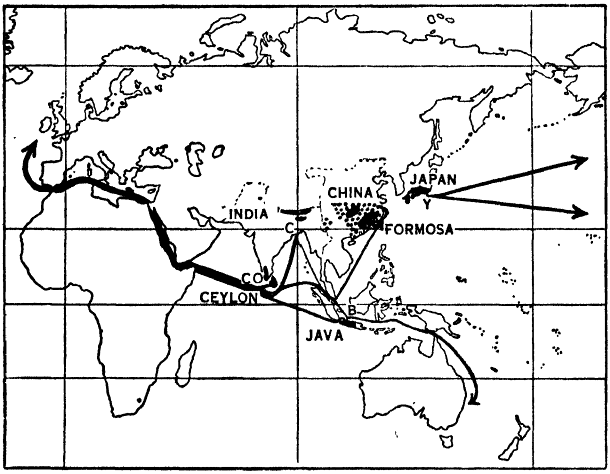

FIG. 95.—Map showing the tea-producing and tea-exporting countries.
The principal lines of export are also shown. Exporting ports: C=Calcutta; Co=Colombo; B=Batavia; S=Shanghai; Y=Yokohama.

Ceylon.—The failure of coffee planting in Ceylon encouraged the rise of tea plantations which have been eminently successful.

The plantations are situated in the hill country south of the old capital, Kandy. Ceylon now ranks next to India as an exporter.

Dutch East Indies.—Tea is an important crop in Java.

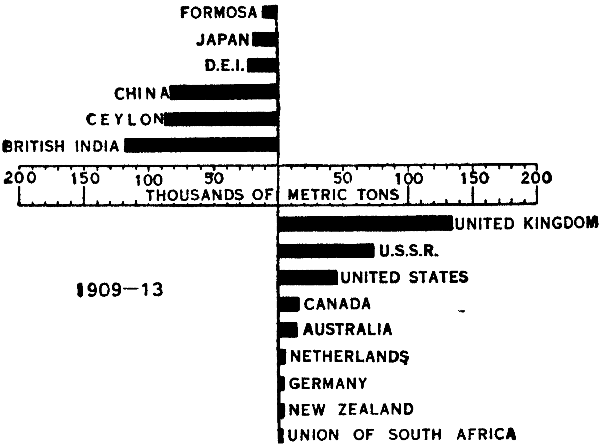

Fig. 96.— World trade in tea, 1909–13.

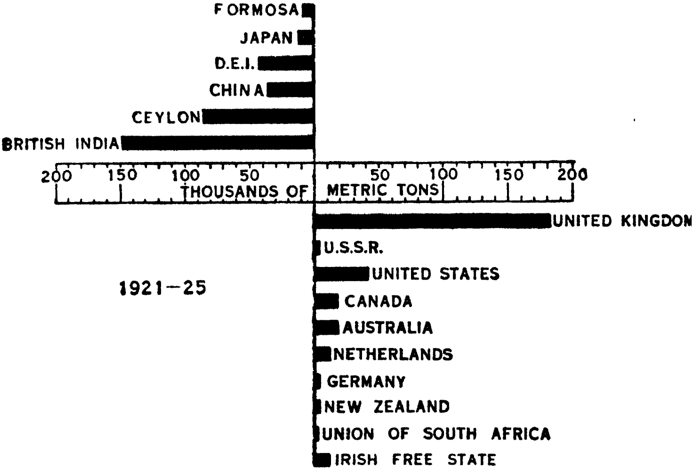

Fig. 97.—World trade in tea, 1921–25.

Japan.—Tea has long been grown in Japan for home consumption, and Japanese tea, mainly green tea which is not very palatable to those used to Indian teas, is now exported in large quantities to the United States. Formosa produces the very choice Oolong and other types.

In pre-war years Great Britain alone purchased nearly half the tea on the world's market and, with the disorganization of Russia, the proportion since the war has been even greater. Russia (taking very low-grade teas) and the United States (deriving the supply largely from Japan) normally take second and third place as importers. The Dutch are large tea drinkers, and are naturally supplied by Java; Canada, Australia, and other parts of the British Empire absorb much of the remainder. London is the world's leading tea market, and there are large re-exports from England.

Maté, Yerba or Paraguay tea, a favourite South American drink, is obtained from the leaves of a tree growing in the Paraguayan forests. It is quite different from ordinary tea.

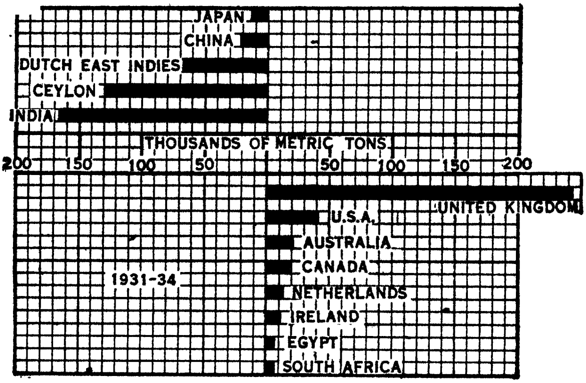

FIG. 98.—World trade in tea, 1931–34.

It is interesting to note the consumption per head of some of the great tea-drinking nations. According to Chisholm's *Handbook of Commercial Geography*, *per capita* consumption is highest in Australia and New Zealand; in Great Britain it is about 9 lbs. per annum. In India it is only about 0·033 lb. per annum. Taking a low average price of 1*s.* 6*d.* or 35 cents a pound, the tea trade represents about £60,000,000 or $280,000,000 annually.

COFFEE

Coffee is obtained by roasting the seeds or "beans" of the coffee-tree (*Coffea arabica*), which is a small tree with shiny, evergreen leaves. The tree continues to flower for several months, and consequently flowers and fruit are found on the tree at the same time, necessitating two or three gatherings per year.

Conditions of Growth.—Like tea, coffee is a subtropical crop, and requires a rich, well-drained soil, preferably cleared forest land. It is less hardy than tea, and cannot stand more than light frosts Moderate heat and rainfall and equable temperatures are the desiderata ; further, protection from the direct rays of the sun is important. The latter is usually obtained by planting protective larger trees, and by restricting the height of the tree, and keeping it pruned down to about 8 feet high. Ideal situations are found on mountain slopes, with rich soil, facing tropical seas. It is interesting to note that in some regions, notably the coast of South-East Arabia, the necessary protection from the sun's rays is afforded by the rising morning mists. The coffee tree is peculiarly liable to disease ; the Ceylon plantations were practically wiped out by disease in the 'seventies and 'eighties of last century. The tree reaches maturity in about six years, and yields profitable crops for twenty-five or thirty years. Much labour is required in coffee planting.

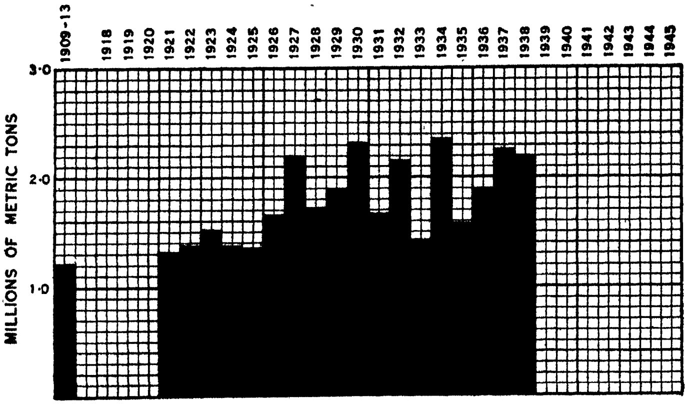

FIG. 99.—World production of coffee in recent years.

The remarkable variations in world production from year to year are due to the fluctuations in the Brazilian total which represents 70 per cent. of the whole.

World Production of Coffee.—Fig. 99 shows the recent annual production of coffee. There is a marked tendency for post-war production to be in excess of pre-war production. At the present time Brazil produces about 70 per cent. of the world's total. Over-production in that country as well as the ravages of disease have resulted in many former producers—amongst which Ceylon, India, and Java may be specially noted—giving up coffee planting in favour of more lucrative plantations such as tea and rubber.

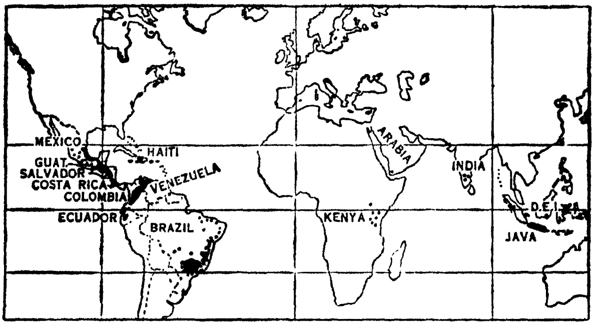

FIG. 100.—Map of the World showing the principal coffee-growing countries
Guat. = Guatemala.

Coffee-growing Countries of the World.—*South America.*—Coffee is the leading commercial crop of Brazil, and the volcanic soils round São Paulo alone produce half the world's total. Owing to the coldness of the valleys the coffee plantations are on the hill-sides, more than 2,000 feet above sea-level. Coffee is an important crop in Colombia, Venezuela, Ecuador, and the Guianas, so that South America is responsible for more than 75 per cent. of the world's total, whilst Central America and the West Indies produce much of the remainder.

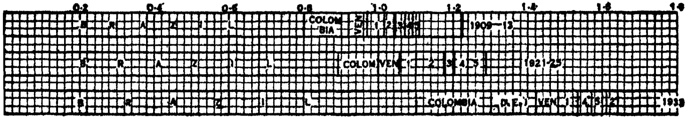

FIG. 101.—Production of coffee in the principal producing countries.
Col. = Colombia; Ven. = Venezuela; Gua. = Guatemala; D.E.I. = Dutch East Indies, mainly Java; Hai. = Haiti; Mex. = Mexico; Sal. = Salvador.

Central America and the West Indies.—Mexico, Guatemala, Salvador and Costa Rica; Jamaica, Haiti and Porto Rico are all large coffee growers. Brazilian coffee is often lacking in quality, so that Jamaica and several of the Central American states specialize in finer grades.

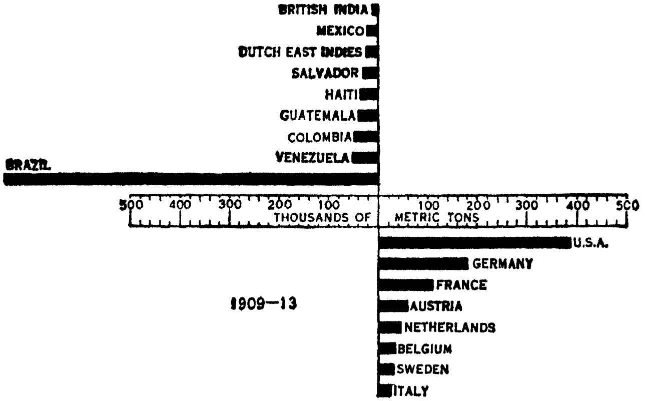

FIG. 102.—World trade in coffee, 1909–13.
"Austria" refers to the pre-war frontiers.

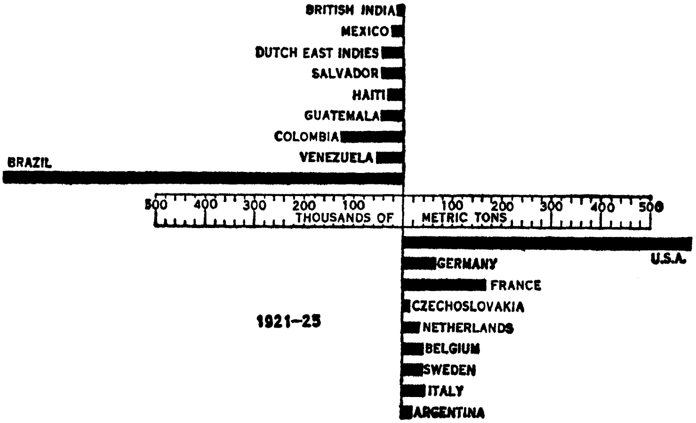

FIG. 103.—World trade in coffee, 1921–25.

Africa.—Though little grown in the country from which it takes its name, Liberian (*robusta*) coffee may be noted as an important variety growing in lowland situations and remarkably resistant to disease. Though the production is small, Kenya is rapidly gaining a name for the quality of its coffee.

Asia.—There is still a large production from Java. In India the coffee plantations are mainly in Mysore, on the Deccan plateau, sheltered by the Western Ghats. Ceylon, once an important grower, has now a negligible output, but Liberian coffee is now being tried there. The famous Mocha coffee is grown in small quantities on the seaward slopes of the plateau in Yemen (southern Arabia).

World Trade in Coffee.—Fig. 102 shows the leading exporting and importing countries. In the United States the annual consumption per head is nearly 12 lbs.; in Europe, Holland, Sweden, and Belgium exceed this amount and France is only a little less. In Great Britain, on the other hand, it is only 2½ lbs. per head.

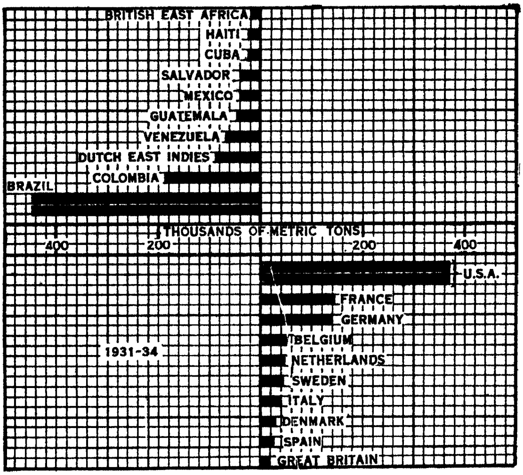

FIG. 104.—World trade in coffee, 1931–34.

Taking the exports at 1·4 million tons, at a low average value of 1*s*. or 25 cents per lb., the annual value of the coffee trade is of the order of £155,000,000 or $750,000,000.

COCOA (CACAO)

Cocoa is obtained from the seeds or "beans" of a small evergreen tree, the cacao-tree (*Theobroma cacao*). The beans occur embedded in a soft white pulp in rows in a large pod which grows from the stem of the tree. The pods are placed in tins in a "sweating home" and the soft pulp ferments and drains away. The beans are then sun-dried, roasted, and the husk removed. The resulting "cocoa-nibs" are ground and some of the fat expressed by pressure before the final grinding. Chocolate is made by adding sugar and retaining some of the excess "cocoa butter" or fat.

Conditions of Growth.—The cacao-tree is essentially an equatorial tree and its distribution is limited to sheltered lowlands within 15°—or at the most 20°—of the equator. The cacao-tree develops a long tap-root and requires therefore a deep soil, humid but well drained. Land cleared of equatorial forest is especially suitable. The climate must be hot, equable and moist, with a good, well-distributed rainfall. Regions with a marked dry season are unsuitable, there must be little wind, which would break the heavy seed pods. It will be noticed that these conditions are practically those characterizing the equatorial climate. The trees, especially when young, must be protected from the direct rays of the sun by other trees grown as shelters. The banana is often used for this purpose. The tree takes twelve years to reach maturity. The steamy atmosphere of the cocoa plantation is one unsuited to white labour.

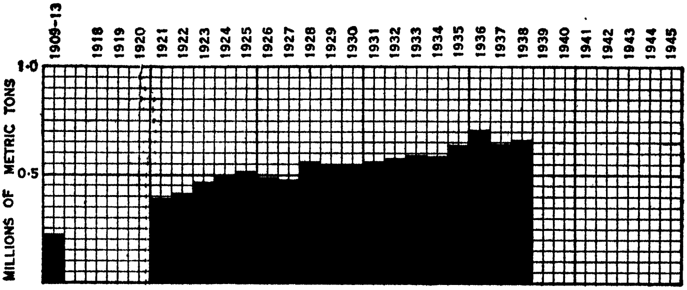

FIG. 105.—World production of cocoa in recent years.

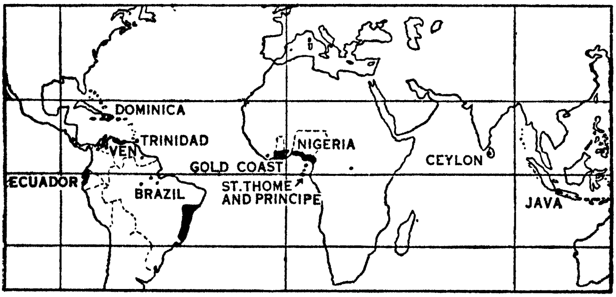

FIG. 106.—Map showing the principal cocoa-growing countries.

World Production of Cocoa.—The world production and consumption of cocoa continue to show a remarkable increase. The average of 1922–26 is more than double the pre-war average of 1909–13, while that, in turn, is double the average at the beginning of the century. The increase in consumption is probably due, not so much to an increase in cocoa-drinking, but to the use of chocolate in confectionery. The United States, Britain, Germany, and Belgium are amongst the leading nations of the world which have a consumption of between 3 and 3½ lbs. per head per annum. As a beverage cocoa is particularly in vogue in Spain.

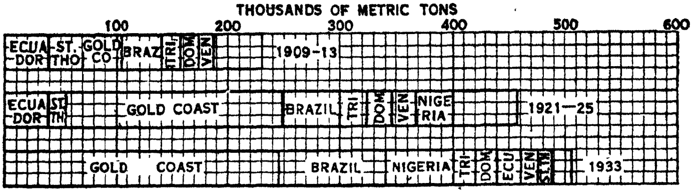

FIG. 107.—Production of cocoa in the principal countries.

St. Tho. = São Thomé and Principe; Tri. = Trinidad; Dom. = Dominican Republic; Ven. = Venezuela; Ecu. = Ecuador.

Cocoa-growing Countries of the World.—Together with the increase in consumption of cocoa, there has been a marked change in the origin of the supply. In 1906 Brazil (16 per cent.), Ecuador (16 per cent.), São Thomé (a small island off the coast of Guinea Africa, 16 per cent.) were the leading producers, whilst the whole of British West Africa only yielded 6½ per cent. In 1924–29 the Gold Coast and Nigeria alone produced about half the world's total and four times as much as Brazil. The leading producers of the present day are shown on Figs. 106 and 107. Apart from the countries

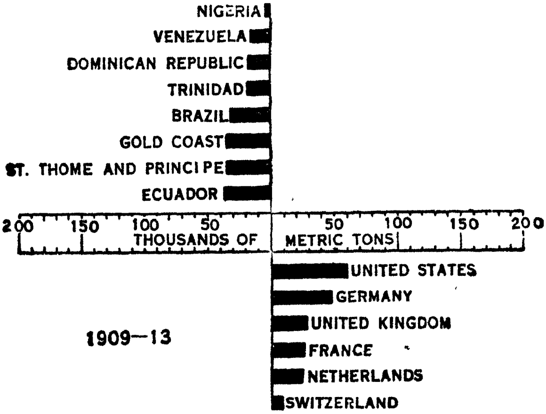

FIG. 108.—World trade in cocoa, 1909–13.

shown on that map, Ceylon and Java have a considerable output.

The Cocoa Trade of the World.—Cocoa as a crop is grown essentially for export; production is in equatorial regions, consumption is mainly amongst the white nations of North America and Europe. Fig. 108 shows the principal exporting and importing countries. The United States draws mainly from South America,

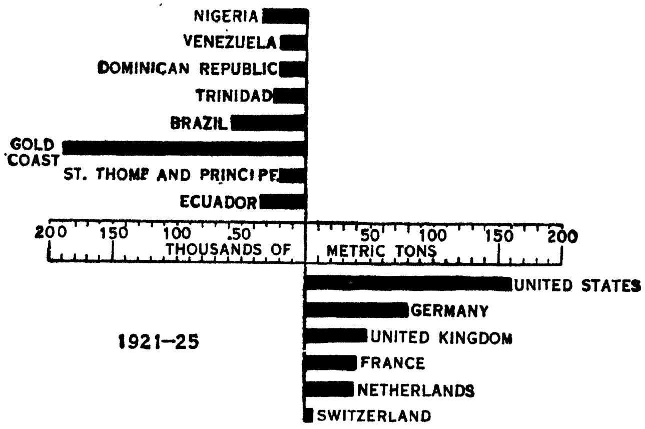

Fig 109.—World trade in cocoa. 1921–25.

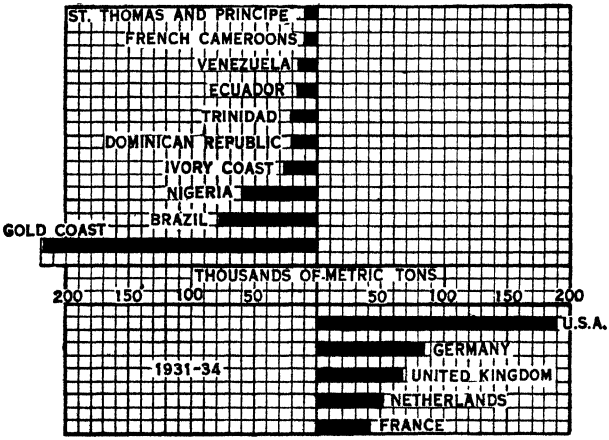

Fig. 110.—World trade in cocoa, 1931–34.

Britain mainly from her West African colonies and the West Indies. Practically the whole output of Fernando Po (Spanish) goes to Spain, whilst France has supplies from her West African colonies. It is notable that consumption in Germany has not diminished as a result of the loss of the Cameroons and Togoland.

In recent years, calculating an export of 500,000 metric tons at an average value of 8*d*. or 16 cents per lb., the total annual value of the cocoa trade is of the order of £37,000,000 or $175,000,000.

FRUITS

The perfecting of methods of cold-storage and transportation, and the increased speed of ocean transport have been instrumental in changing the fruit trade from a local to a world-wide one. In addition to the trade in fresh fruits, there is an enormous industry connected with the canning and preserving of certain fruits, and in the drying of others. Certain fruits amongst which may be mentioned the mango and papais (paw-paw), deservedly popular in their native countries, have scarcely yet become articles of international commerce. We shall consider here only those fruits which, fresh, dried, or canned, enter into world trade.

The important fruits may conveniently be grouped into four classes:

(*a*) Tropical or subtropical fruits—bananas, pine-apples, and dates.

(*b*) Citrus fruits—oranges, lemons, grape-fruit, and limes.

(*c*) Grapes.

(*d*) Deciduous fruits, *i.e.* fruits from deciduous trees which lose their leaves in the cold season—apples, pears, almonds, peaches, apricots, nectarines, figs, plums, and cherries.

Tropical and Subtropical Fruits.—*Bananas* are the fruit of a soft-stemmed plant, 8 to 12 feet high, with very large simple leaves. The genus *Musa* grows in most tropical and subtropical countries where the supply of moisture is adequate and the bananas of commerce are obtained from a number of species. Although bananas are widespread for purposes of local consumption only a few countries specialize in large-scale production for the overseas markets. The Central American lands and the West Indies, led by Jamaica, Costa Rica, and Colombia are large exporters; the Canary Islands, where the bananas are grown on carefully terraced and irrigated volcanic hill-slopes, have a large European trade, and the Hawaiian Islands send large supplies to the United States. The bananas are picked green and transported in specially cooled holds of steamers kept at an even temperature of 52°.

Pine-apples are the fruit of a low plant which has no stem, but sends up long, stiff, sharp-pointed, fleshy leaves. The pine grows in the centre. A native of America, the pine-apple requires a rich, moist but light, even sandy, soil, especially near the sea, and has spread to most of the suitable localities in tropical and subtropical lands. As with the banana only certain countries specialize in production for the overseas markets. The international trade in canned pine-apple is more important than that in the fresh fruit. America is supplied by home-grown Florida fruit as well as from Hawaii and the West Indies (especially Cuba). Europe is supplied partly by the Azores and Canary Islands as well as by the tinned fruit from Hawaii, Singapore, and elsewhere.

Dates are essentially the product of the Hot Desert regions, where they form the staple food over large areas. The date palm flourishes in the oases, and wherever a little water is available right across North Africa, Arabia, Persia, and India, and has been introduced into Lower California. Large quantities are exported from Persia and Iraq through the port of Basra, and fine quality dates are exported from Morocco, Algeria, and Tunis.

Citrus Fruits.—The citrus fruits flourish in the frost-free areas of Mediterranean climates and in the regions included in what we have called the warm temperate climate, notably Florida and China.

Oranges.—The orange tree, a small, bushy, evergreen tree with shiny leaves, is a native of China, but became firmly established in the Mediterranean countries in the Middle Ages. Until comparatively recently Spain and Italy had almost a monopoly of foreign trade, but the amazing development of orange growing in California and Florida has enabled those states not only to supply the whole of North America, but to have a large surplus for export. The citrus industry of California is widely acknowledged as the most soundly organized agricultural enterprise in the world with an annual production of between 15,000,000 and 30,000,000 boxes of fruit. Florida is not far behind with over 20,000,000. Of still more recent growth is the citrus industry of the West Indies, South Africa, the Mediterranean tracts of Australia and Brazil (now the world's second exporter). The last three, being in the Southern Hemisphere, can place their fruit on European markets when supplies are otherwise scarce.

Lemons have roughly the same range as oranges, but Europe, notably Sicily, still retains the largest hold on international trade.

Grape-fruit have been developed and perfected in recent years and are characteristic of the newer lands of Florida, California, and South Africa rather than of the older Mediterranean countries.

Limes require a warmer climate and are cultivated largely in the West Indian Islands.

Grapes.—It will be convenient here to deal at the same time with grapes and the products—especially wine—derived therefrom. The grape vine is essentially characteristic of lands where the summer is hot and dry, and is now extensively grown in all the five great Mediterranean regions. The vine has a long tap root which enables it to draw water from great depths during summer droughts. The two absolutely essential conditions are a long, dry, sunny summer with a mean temperature of at least 60° F. in the last month (September in the Northern Hemisphere) and a rainfall sufficiently light to prevent the juice of the grapes becoming too watery. Provided these conditions are satisfied, a Mediterranean climate is not essential, and the vine ranges as far north as the Loire in France and as far as 53° N. in parts of Germany and Poland. Aspect is important, sunny slopes are preferable to valley bottoms where cold air may accumulate. The vine is peculiarly liable to disease notably the dreaded " phylloxera."

Grapes as a fresh fruit are exported mainly from districts where they will not produce good wine. American table grapes are grown round the Lakes: Algeria, Portugal, Spain, and Germany supply Great Britain.

Dried Grapes form an important article of international trade. Raisins and muscatels are dried on the vines by partly cutting the stalk of the bunch. Large quantities are produced by Spain (Muscatels and Valencias), California, and Asia Minor, whilst production in South Africa and Australia is increasing. The smaller, seedless sultanas come from the Ægean Islands and Smyrna, whilst the tiny currants are practically a Greek monopoly, being grown in the neighbourhood of Patras and forming by far the most important export from Greece.

Wine may be described as the national drink in France, Spain, Portugal, Switzerland, and Italy, and is produced in most vine-growing countries except California. Wine is the fermented juice of the grapes. For " sweet " wines the grapes are picked before being fully ripe and fermentation is allowed to go on for only a limited period, so that only part of the sugar is converted into alcohol. " Dry " wines, on the other hand, are fully fermented. The character of a wine is influenced in an extraordinary way by the conditions of soil and climate in which the grapes are grown, as well as by the details of manufacture. As a result, the various types of wine are curiously localized. In France champagne comes from the dry, chalk hills of Champagne around Reims ; true Burgundy from the slopes of the Côte d'Or, near Dijon ; most of the well-known brands of claret are from the banks of the Garonne, near Bordeaux. In Spain sherry derives its name from Jerez, near Cadiz ; port comes mainly from the Douro Valley of Portugal. Amongst Italian wines the sharp-flavoured chianti from Tuscany and the mellow asti from Piedmont. German hocks come from the Middle Rhine Valley, moselle from the valley of the river of that name. It should be borne in mind that the bulk of the wine consumed in France or Italy is "vin ordinaire," red or white, and not dignified by any special name. Large quantities are now grown in Algeria for consumption in France. In the Southern Hemisphere wine is extensively made in Australia, South Africa, Argentina (around Mendoza), and Chile. In Australia it is usual to name the wines after well-known French types, but in character they have features entirely their own. Fig. 111 shows the principal wine-producing regions of Europe; for details of wine production in the Southern Hemisphere reference should be made to the sections on Australia, South Africa, and Argentina in Part II. Fig. 112 shows the production of wine in the principal countries. Calculated at the low average rate of about 3*d.* or 6 cents per litre (1*s.* 1½*d.* or 27 cents a gallon) the wine produced in the world would be worth about £215,000,000 or $1,000,000,000 annually.[1]

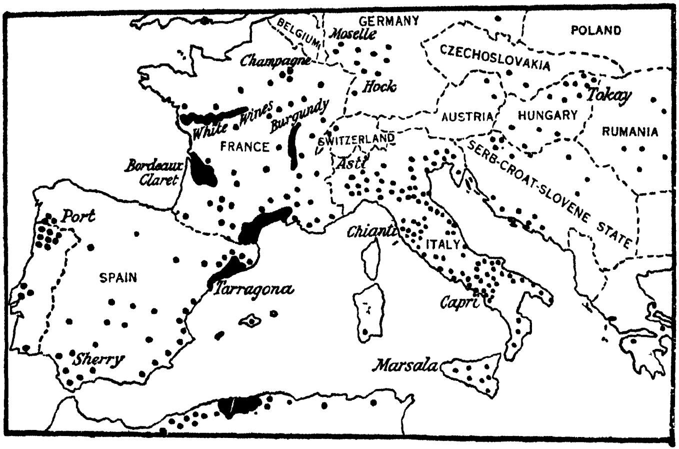
BELGIUM
GERMANY
POLAND
Moselle
Champagne
CZECHOSLOVAKIA
Hock
Tokay
White Wines
Burgundy
AUSTRIA
HUNGARY
RUMANIA
FRANCE
SWITZERLAND
Bordeaux Claret
Asti
SERB-CROAT-SLOVENE STATE
Port
Chianti
ITALY
SPAIN
Tarragona
Capri
Sherry
Marsala

Fig. 111.—Map showing the wine-growing countries of Europe, with the names of the most important types of wine produced.

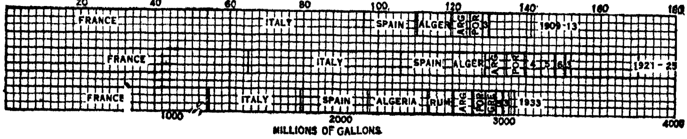

Fig. 112.—Wine-production of the principal countries.
Notice the large post-war increase. 1 = Argentina; 2 = Portugal; 3 = Chile; 4 = Rumania; 5 = Hungary; 6 = Yugoslavia.

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[1] 1 hectolitre = 100 litres = 100 × 0·2200967 gallons.

Deciduous Fruits.—The remaining important fruits which enter largely into commerce come mainly from trees which lose their leaves in the winter and hence are known collectively as deciduous fruits. They fall into two rough groups:

(*a*) Mediterranean fruits—peaches, apricots, nectarines, and figs, with these may be included the almond, valued for its nuts, and the olive, valued for its oily fruits, though the olive is scarcely a deciduous tree.

(*b*) Cool temperate fruits—apples and pears. Plums and cherries flourish also in Mediterranean lands; whilst a number of fruits derived from small deciduous bushes are especially important in England (red and white currants, black currants, gooseberries, raspberries, etc.).

We cannot deal here in detail with these various fruits, except to note that the extension of canning and preservation of them fresh by cold storage has made all of them articles of world-wide commerce. Canadian, Australian, and Tasmanian apples are thus particularly important in European markets. South Africa has recently become important in supplying soft fruits.

OIL SEEDS AND OILS

Olive Oil.—Olive oil is obtained from the oily fruit of the olive tree, *Olea europea*, a native of the Eastern Mediterranean. It is a small, slow-growing tree, with pale, silvery-green foliage, and is essentially a Mediterranean tree. It rarely grows in regions other than those with a typical Mediterranean climate. In South European countries olive oil may be said to take the place occupied by butter or other animal fats in the culinary requirements of the nordic races. Olive oil is pre-eminently a product of Spain, Italy, Greece, North Africa, Portugal, Southern France, and the Eastern Mediterranean. The tree grows well in the Mediterranean areas of Australia and America.

Coconut Oil.—The Coconut Palm (*Cocos nucifera*) is a denizen of the sandy shores of tropical lands, though it will grow in plantations some distance from the sea. Of all palms it is, perhaps, the most graceful, and is the one indissolubly associated with tropical scenery in the imagination of dwellers in temperate lands. The thick outer coating of the coconut yields a valuable fibre, coir, much used for the manufacture of matting. The dried flesh of the nut is known as copra, from which coconut oil is extracted by various processes of grinding, heating, and pressure. In some cases the oil is extracted in the countries where the nuts are grown, in other cases the trade is in the form of copra. After the oil has been extracted from the copra, the residue is ground up into meal, known as poonac, for feeding cattle. Desiccated coconut, used in confectionery, is carefully dried and flaked kernel. As an article of home consumption, coconut oil is used in cooking and for a variety of purposes; in the economy of the white races it is used mainly in the manufacture of margarine, soap, and candles. In 1929–32 exports of coconuts averaged about 210,000 metric tons, against 1,200,000 metric tons of copra and 340,000 metric tons of oil from the countries of origin.[1] Figs. 113–115 are concerned with copra as being the most important form in which the products enter commerce. There is a considerable trade in coconuts between the West Indies and the United States.

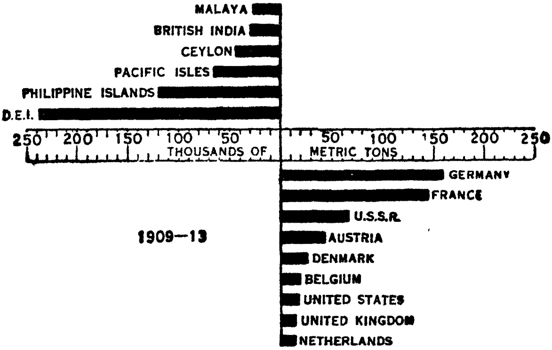

FIG. 113.—World trade in copra, 1909–13.
"Austria" refers to the pre-war frontiers.

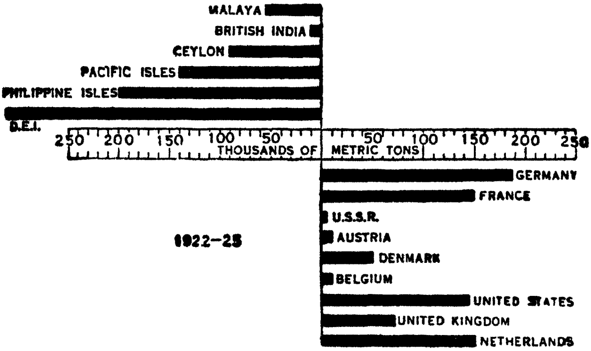

FIG. 114.—World trade in copra, 1922–25 (approximate only).

Palm Oil.—In tropical West Africa the African Oil Palm (*Elaeis* „..*neensis*) takes the place of the Coconut Palm of tropical Asia and East Africa. The oil is obtained from the great bunches of grape-like clusters of fruits—600 to 2,000 in each bunch. Ordinary palm oil is obtained from the pulp surrounding the hard nuts and is used in the manufacture of soap and candles, also as a lubricant and in the tin-plate industry; palm-kernel oil is obtained from the kernels inside the nuts and is used for making margarine. All the West African countries yield palm oil, but in production Nigeria easily leads.

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[1] 1909–13 figures were 130,000; 550,000 and 50,000 tons.

Ground Nut Oil is obtained from the underground "nuts" (commonly known as pea-nuts or monkey nuts) of a small annual plant of the pea family. The plant thrives in dry, light soils in tropical and semi-tropical lands. India, China, Nigeria, Senegal, and other parts of West Africa (drier parts of the tropical climate region) are the leading exporters.

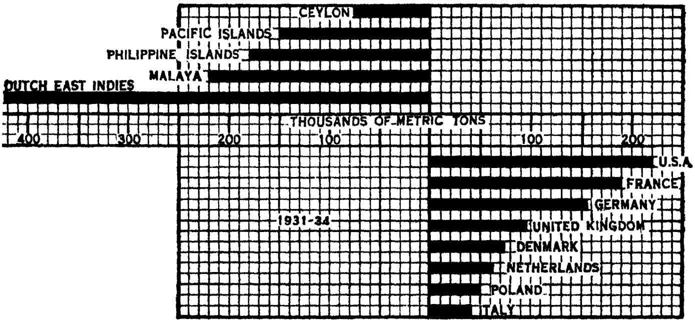

FIG. 115.—World trade in copra, 1931–34.

Other Oil Seeds include *rapeseed*, especially from India and Rumania; *sesamum*, mainly from India and China; *linseed* from Argentina, India, and Canada; *cotton seed* from the great cotton-growing countries, though exported mainly by India and Egypt; *castor oil* and *soya beans*, grown and exported in China, Manchuria and Korea (now forming the leading export of Manchuria).

SPICES

In the early days of commerce between Europe and the East, spices figured very largely, since they satisfied the necessary conditions of small bulk and high value. Many of the famous old spice ports—such as Malacca in Malaya—are now but unimportant backwaters. All the spices may be classed as equatorial or tropical products.

Pepper is obtained mainly from Malaya, the East Indies, and India.

Ginger is produced in China, Indo-China, India, Sierra Leone, and Jamaica.

Cloves come mainly from Zanzibar.

Cinnamon is from Ceylon.

Vanilla, a native of Mexico, is now largely produced also in Réunion, Madagascar, the Seychelles, and Java.

TOBACCO

Tobacco is obtained by drying or " curing " the leaf of several species of a genus of plants known as *Nicotiana*. *Nicotiana tabacum* is a native of America, and the United States still produces between a third and a half of the world's supply. The habit of smoking is now almost universal, and the map, Fig. 117, shows the widespread nature of tobacco cultivation. In recent years there has been a marked decrease in cigar smoking, but a huge increase in cigarettes. Cuba is particularly famous for the finest quality cigar-leaf. It is generally true that heavy soils produce a stronger tobacco than light soils. Tobacco is mainly a subtropical or tropical crop, but if protected from frost can be grown in temperate lands. It is an annual plant and can be grown as a summer crop in countries suffering from winter frosts.

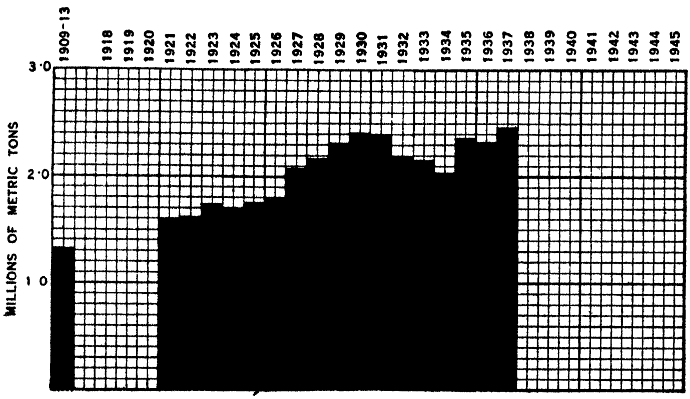

Fig. 116.—World production of tobacco.
(Excluding a number of countries for which figures are not available.)

In many countries, as in India, the crop is grown mainly for home consumption. According to the *Commerce Year Book* about 1,000,000 lbs., or 4,550 metric tons, of leaf tobacco enter the world's trade channels annually. Of this amount (1924-25) the United States furnishes over 50 per cent. ; the Dutch East Indies

20 per cent. ; Brazil 8 per cent. ; Greece 9 per cent. ; the Philippine Islands 6 per cent. The leading importing nations are Germany, the United Kingdom, France, Netherlands, Spain, Belgium, Austria, Czechoslovakia, and China.

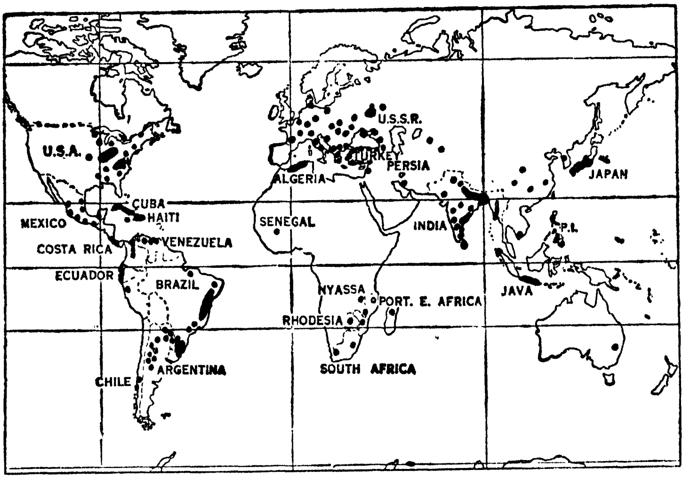
U.S.A.
MEXICO
CUBA
HAITI
COSTA RICA
VENEZUELA
ECUADOR
BRAZIL
CHILE
ARGENTINA
U.S.S.R.
TURKEY
PERSIA
ALGERIA
SENEGAL
INDIA
NYASSA
PORT. E. AFRICA
RHODESIA
SOUTH AFRICA
JAPAN
P.I.
JAVA

FIG. 117.—Map of the World showing the principal tobacco-growing countries.

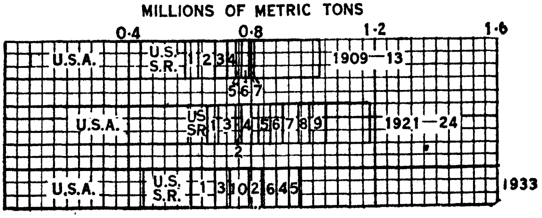

FIG. 118.—Production of tobacco in the principal tobacco-growing countries; not including India, which has an annual production probably about 0·25 million tons.

1 = Germany; 2 = Greece; 3 = Cuba; 4 = France; 5 = Bulgaria; 6 = Algeria.
In 1903–13 countries producing between 10,000 and 20,000 metric tons included Bulgaria, Mexico, Korea, Dominica, Italy, and Algeria.
In 1926–29 countries producing between 10,000 and 20,000 metric tons included Rumania, Yugoslavia, Canada, Mexico, Porto Rico, Dominica, Korea, and Argentina; over 20,000 tons included Germany, Bulgaria, France, Greece, Hungary, Italy, Cuba, Japan, Philippines, Turkey, Algeria, Brazil, and D. E. I.

EXERCISES

1 Bring Figs. 90, 92, and 93 up to date. What conclusions can you draw regarding the trend of beet-sugar production?

2. Bring Figs. 94 and 98 up to date.

3. Bring Figs. 99, 100, and 104 up to date. What conclusions can you draw regarding the main areas of coffee production?

4. Complete Figs. 105, 107, and 110.

5. By reference to the *Statesman's Year Book* or the *Year Books of the Union of South Africa* and the *Commonwealth of Australia*, study the progress of the citrus industry in South Africa and Australia. Compare its progress with that in the United States.

6. Bring Fig. 112 up to date. Taking population figures from the *Statesman's Year Book*, calculate the *per capita* production of wine in the principal countries.

7. Draw diagrams to show world trade in tobacco. Figures may be obtained from the *Commerce Year Book.*

EXAMINATION QUESTIONS

1. What are the chief sources of sugar in the world? Which of them seem capable of rapid extension? (*Univ. Bristol Inter.*, 1924.)

2. Describe and explain the distribution of the beet-sugar industry in Europe, and discuss the consequences which would arise from its successful development in Great Britain. (*Univ. Bristol Inter.*, 1925.)

3. State the reasons why *four* European countries maintain their supremacy in the wine industry. (*Prov. Alberta Matric.*, 1927.)

4. Name the soil and climatic requirements for the production of the best quality of coffee and indicate the region in which these conditions are best combined. (*Prov. Alberta Matric.*, 1927.)

5. Write an account of the distribution of olive culture and of the olive oil industry of the Mediterranean. (*Univ. London B.A. Hons. Econ. Geog.*, 1927.)

6. Write notes on the sources of the world supplies of rubber, cane-sugar, and cocoa. (*Univ. London Inter. B. Com*, 1924)

7. Discuss the present distribution of beet-sugar production in Europe. (*Univ. London Inter. B. Com*, 1923)

8. Write notes on the conditions of soil and climate favourable to the production of any *two pairs* of the following: barley and rice, coffee and cacao, flax and jute. (*Univ. London Inter. B. Com*, 1928)

9. What do you know of the world production of, consumption of, and trade in, *either* wine *or* vegetable oils? (*Univ. London Inter B. Com.*, 1928.)

10. Locate as carefully as possible the chief vine growing areas of France and show in what ways each area is suitable for viticulture. (*Univ. London Inter. Arts.*, 1930.)

11. What are the main sources of vegetable oils? State briefly the geographical conditions necessary for the production of each of the main types. (*Univ. London Inter. B. Com.*, 1932.)

12. Discuss the importance of the regions between the Tropics as sources of food products for the temperate regions. (*Univ. London Higher Schools B & D*, 1932.)

13. Agriculture is limited in temperate lands by (*a*) excessive, (*b*) insufficient rainfall. Elaborate this statement. (*Univ. London Higher Schools E*, 1932.)

14. Explain and illustrate the statement that a country may be a relatively large producer of a given commodity without exporting much of it, and *vice versa*. (*Univ. London Higher Schools E*, 1932.)

15. How far is the British Empire capable of supplying the needs of the Home Country in foodstuffs and raw materials? (*Univ. London Inter. B.Sc. (Econ.)*, 1934.)

CHAPTER VIII

MEAT, DAIRY PRODUCE, AND FISH

CATTLE

CATTLE are found in all tropical and temperate lands, except in densely forested areas or in regions too rugged or too dry for the adequate growth of grass. Cattle require richer grass than sheep, and in those countries where both cattle and sheep are reared the cattle usually predominate in the wetter regions, the sheep in the drier. This is well seen in Australia, New Zealand, Argentina, or the British Isles. Cattle have three principal uses:

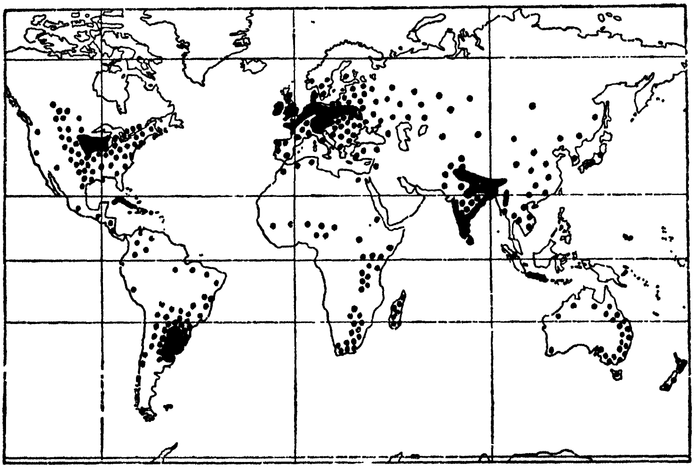

FIG. 119.—Map of the World showing distribution of cattle.
Identify all the important areas.

(a) As draught animals.
(b) For the production of beef.
(c) As dairy cattle for the production of milk.

In India, cattle are typically draught animals and the bulk of the ploughing is performed by cattle-drawn ploughs. The Hindus regard the cow as a sacred animal, and do not eat beef; the Mahommedans eat but little. Further, the milk yield is poor and low. In many parts of Africa, China and Japan the cattle are primarily draught animals, but in most other parts of the world cattle are reared either as beef or as dairy cattle. Beef cattle thrive on the wide, open grasslands, and require comparatively little attention; dairy cattle, on the other hand, not only require constant attention —the milking of the cows twice daily—but on the whole need a richer and more carefully regulated diet. Climate, food supply, labour supply, distance and accessibility of markets determine the development of dairying or beef industries. In those countries in which mixed farming is the usual rule, and of which Great Britain affords a good example, both beef and dairy cattle are kept.

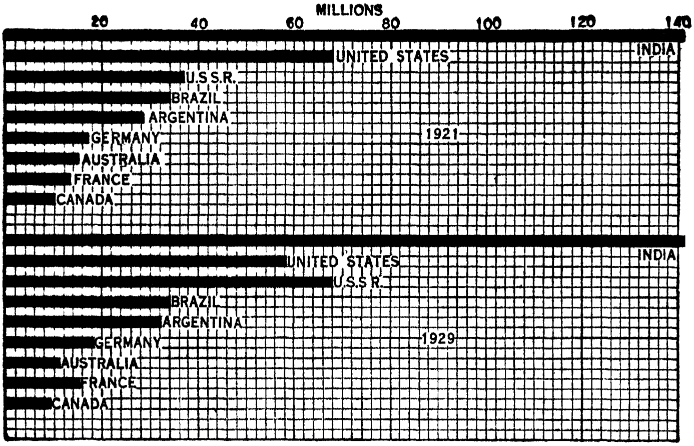

FIG. 120.—Numbers of cattle in the principal countries.

Fig. 119 shows the distribution of cattle in the world, and Fig. 120 the numbers in the principal countries.

Beef.—The local supply of fresh beef is insufficient for the needs of the North-West European countries, especially of Great Britain, and large quantities are imported. Europe has, however, produced the best beef cattle, and the vast herds now found on the grassy plains of the New World and Australia have been bred from imported European animals. At the present time there is a regular export trade in pedigree bulls from England and France for the improvement of foreign herds.

Prior to the discovery of the processes of freezing and chilling, the international trade in beef was confined to jerked or salted beef and to live animals. In recent years the trade has been almost entirely in "chilled" or "frozen" beef. "Chilled" meat is transported in cold-storage chambers, kept at a temperature of 30° F.; "frozen" meat is actually frozen hard at temperatures between 10° F. and 15° F. There is also a considerable trade in tinned (partly cooked) beef, tongues, and extracts.

The South American temperate grasslands, more than any other region, are devoted to beef production. The River Plate region, with Argentina on the one side and Uruguay on the other, is the chief exporting area. Argentina is the largest exporter of beef in the world, and supplies two-thirds of Britain's import. The cattle area extends into South Brazil (Rio Grande) and into Paraguay, but Brazilian cattle are of poorer quality. The main ranching area of North America is on the high western prairies. Although too dry for agriculture, the cattle are allowed to roam over huge areas, and thereby find sufficient sustenance. They are often sent in large numbers to the maize belt for fattening before slaughter. The other great beef-producing area is in the west of the maize belt, where fodder is cheap. This area centres on Chicago, where are situated the well-known meat-packing works. In Australia beef cattle are reared on large ranches on the tropical and subtropical grasslands of Queensland and North Australia.

The extension of wheat cultivation in North and South America has tended to restrict the area suitable for cattle, and there are signs of the development of cattle ranching in new areas. Of these, the sparsely populated tropical grasslands or savanas of Africa are the chief regions awaiting development. It is probable that the future of such countries as Northern Rhodesia, Southern Rhodesia, Angola, and the Sudan is bound up with the extension of cattle ranching.

In the older countries of Europe, the Mediterranean lands of Spain, Portugal, and Italy, beef cattle are more important than dairy; Great Britain, France, Germany, Central Europe, and Russia have roughly equal numbers of each, but the smaller countries of Switzerland, Holland, Denmark, and the Baltic States are essentially dairying countries.

Dairy Produce.—Fig. 121 shows the principal dairying countries. It is of interest to contrast this map with Fig. 119, showing the distribution of cattle as a whole. The limited regions devoted essentially to dairying are noteworthy.

Dairy produce as a whole, including under that term milk, butter and cheese, is particularly important amongst the white races of North European extraction. In Mediterranean lands olive oil to a large extent takes the place of butter; in tropical lands coconut oil and other fats and oils are more important. Most regions in cool temperate latitudes obtain the bulk of their dairy produce locally; export trade on a large scale is in the hands of a comparatively small number of nations. We will deal here with the international trade.

Milk.—Milk enters into commerce either fresh, condensed and tinned, or powdered. The perfecting of cold storage has made possible a large trade in fresh milk, but obviously such a trade requires elaborate and perfect machinery for handling from producer to the ultimate consumer. Condensed milk, on the other hand, can be sent by all ordinary means of transport. It is usually possible, for example, to purchase tins of condensed milk in the

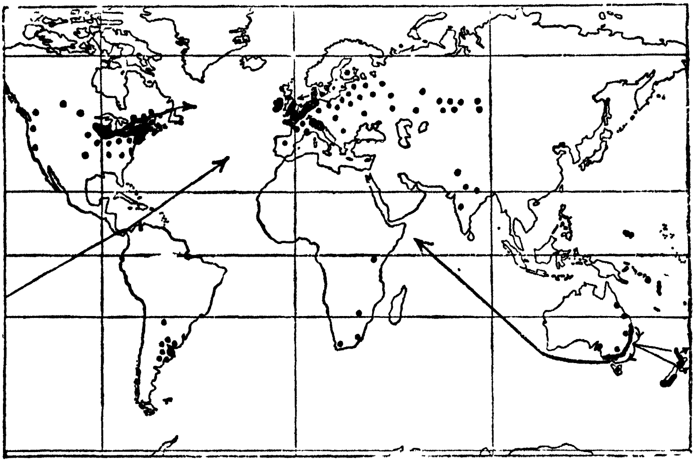

FIG 121 —Map of the World showing the principal dairying countries. The arrows indicate those regions from which there is an export of dairy produce.

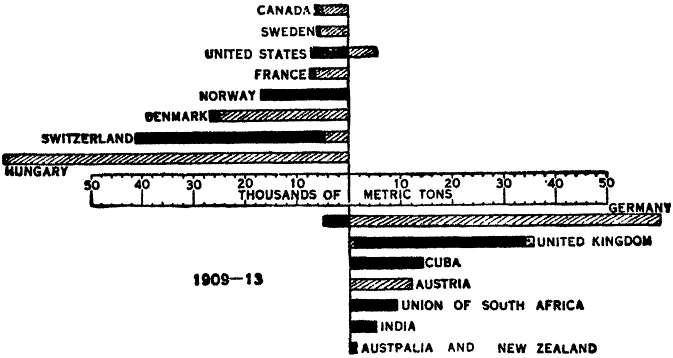

FIG. 122.—World trade in milk, 1909–13.
Particulars for the Netherlands not available. Black = condensed milk; lined = fresh milk; dotted = dried milk.

bazaar in the most out-of-the-way villages in the hills of India, scores of miles from a railway. Milk dried and powdered (or desiccated milk) packs into a very small space, and, though early attempts at drying milk were not very successful, modern "spray dried" milk is said to be indistinguishable from fresh milk when reconstructed. Figs. 122 to 124 explain themselves.

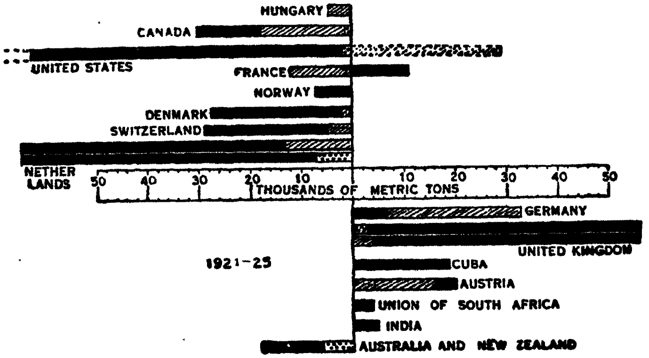

FIG. 123.—World trade in milk, 1921–25.

Signs as in last figure. The quantity shown for the United States is the *net* export after deducting the large import shown by dotted lines. Notice that the pre-war import of Australia and New Zealand has been changed into a large post-war export.

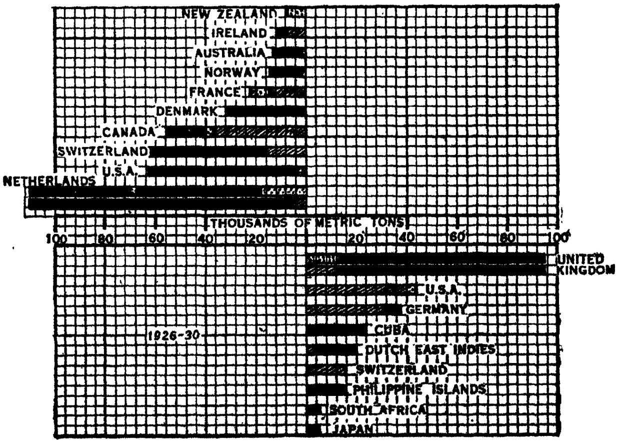

FIG. 124.—World trade in milk, 1926–30.

Butter.—It is interesting to note that there is a marked tendency to specialization in the great dairying regions. A country preparing dairy produce for export tends to specialize in milk *or* butter *or* cheese, rather than in all three simultaneously. This is largely due to the difficulty of establishing an international reputation for a particular product, so that, when a reputation is well established, all efforts are directed to maintaining quality and quantity. In England we thus associate Denmark with butter, but Holland

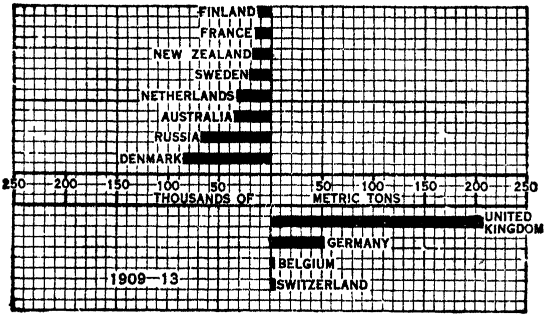

FIG. 125.—World trade in butter, 1909–13.

It should be noted that the international butter trade of the world is directed mainly towards supplying the needs of Great Britain, and, to a less extent, those of Germany.

with cheese; Switzerland with milk and cheese, but not with butter. Figs. 125 to 127 show the butter trade of the world. At an average price of 1*s*. or 25 cents per lb., the world exports

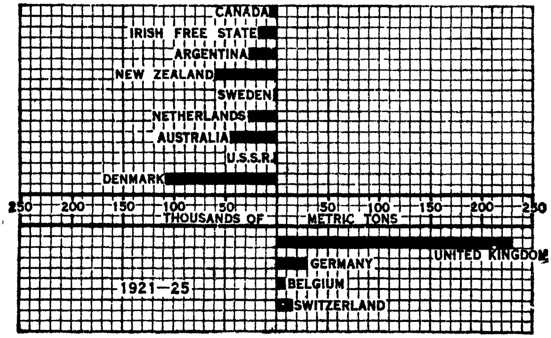

FIG. 126.—World trade in butter, 1921–25.

Notice the new producers.

in butter have an annual value of the order of £60,000,000 or $300,000,000.

Cheese.—There are numerous varieties of cheese, which, like the numerous varieties of wine, are closely associated with definite localities. The well-known types take their name from the European

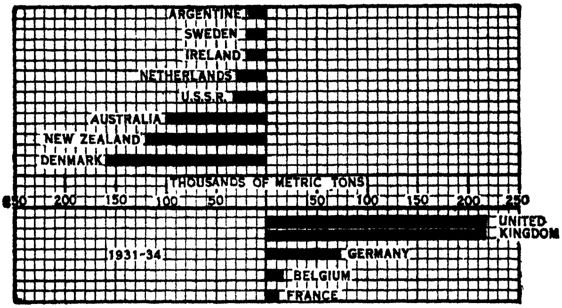

FIG. 127.—World trade in butter, 1931–34.

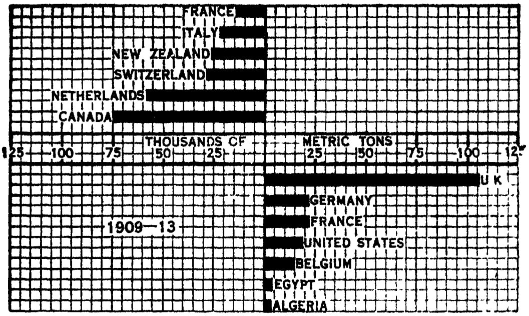

FIG. 128.—World trade in cheese, 1909–13.

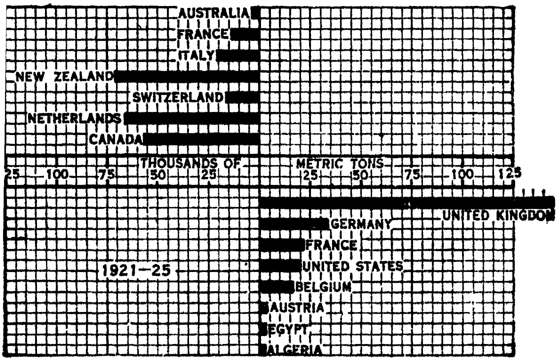

FIG. 129.—World trade in cheese, 1921–25.

areas where they are produced, but, as with wine, comparable types are now to be obtained from the newer countries. Figs. 128 to 130 show the world trade in cheese. At an average price of 6*d.* or 12 cents per lb., the world exports in cheese have an annual value of the order of £30,000,000 or $150,000,000.

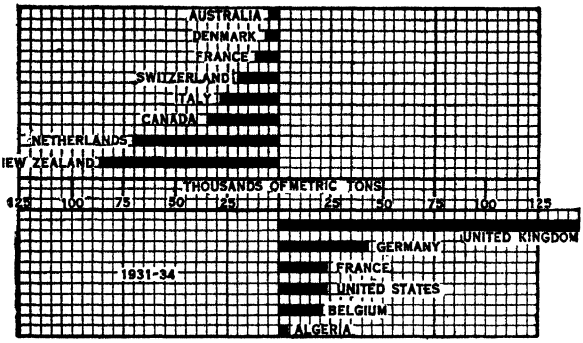

FIG. 130.—World trade in cheese, 1931-34.

Hides.—Before terminating this section on cattle, reference must be made to the trade in hides. All cattle produce hides, whether they be draught-, beef-, or dairy-cattle. Consequently the trade is widely distributed. Argentina, Brazil, and India rank amongst the leading exporters, the United States and Germany amongst the leading importers.

SHEEP

As with cattle, sheep may be reared for more than one reason —for wool, meat, or milk. Roquefort and certain other well-known cheeses are made from ewe's milk, the sheep in certain districts of Southern France, Southern and Central Italy being important for this purpose. In most parts of the world, however, sheep are important either for mutton or for wool. Sheep which yield the best meat do not yield the best wool and *vice versâ*. We shall consider the production of wool in the next chapter. Here we may note that sheep bred for mutton require a damper climate and better pasture than do those bred for wool. Mutton sheep are heavy, well-fed animals, thriving in such cool temperate climates as are found in the British Isles and New Zealand. In the exports of mutton and lamb, New Zealand, with her famous "Canterbury Lamb," easily leads (see section on New Zealand). The South American countries—Argentina, Uruguay, and Chile—take second place, followed by Australia. The bulk of the imports are absorbed by Great Britain. The average export of frozen meat from New Zealand in 1929–32 was about 200,000 tons, the bulk of which was mutton and lamb. This represents nearly half the total international trade in the commodity.

PIGS

Pigs can be reared under a great variety of climatic conditions. They are omnivorous feeders and can be kept largely on waste and refuse, and are often reared in confined spaces in thickly populated areas. The distribution map shows their curiously irregular distribution—determined mainly by conditions other than geographical. In Mahommedan countries the pig is regarded as an unclean animal, hence the absence of pigs from Asia Minor to Further India. On the other hand, fat pork is a favourite food of the Chinese, and pigs are abundant throughout China. Elsewhere, the three great pig-rearing regions are the maize belt of the United States; North-Western and Central Europe; Brazil and Argentina. The trade in fresh pork is very small when compared with that in beef or mutton. This is to a considerable extent due to the comparative indigestibility of fresh pork. Although the old "salt pork" has disappeared together with salt beef, pork is improved by salting and smoking, and it is thus, in the form of *bacon* and *ham*, that pig flesh enters mainly into commerce. *Lard* is the fat of pigs melted down, and pigs are especially fattened for the production

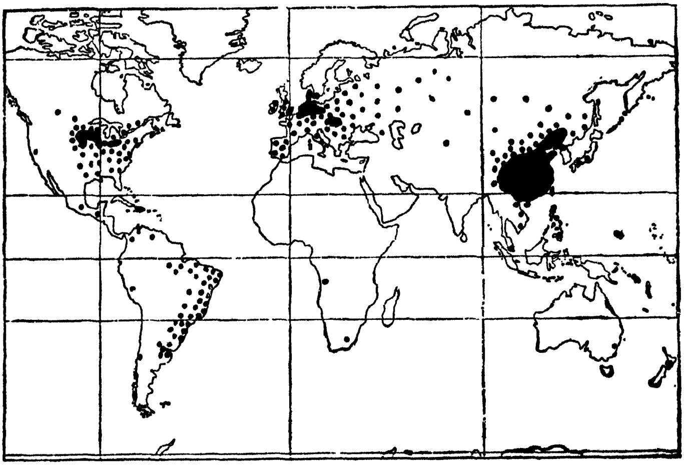

FIG. 131.—Map of the World showing pig-rearing countries.

of lard in the United States. The United States controls the bulk of the world trade in lard. The hard, stiff, *pigs' bristles* are also important commercially. Canned or tinned pork is prepared in huge quantities in the United States. The wholesale slaughtering and meat-packing industry has a greater value than any other industry in the United States except motor-manufacture. Of the meat and animal fats prepared for export the bulk are pig products. In 1930-33, 120,000 metric tons of meat were exported of which 74,000 tons were pig products, whilst animal fats represented a further 299,000 metric tons, the bulk consisting of lard. Other leading exporters of bacon are Denmark, Canada, and Ireland; of pork, Holland and Argentina. Like the trade in cattle hides, that in pigs' bristles is more widespread than in other pig products; China and Russia are big exporters.

POULTRY

The world trade in eggs is larger than one is apt to imagine, largely because of the use of albumen or dried "white" of eggs in the arts—in bookbinding, leather-working, calico-glazing, and in wine-clarifying. Over short distances eggs are sent fresh. Thus Denmark and Ireland supply Great Britain with large quantities of fresh eggs. The huge exports from China (the leading exporter), Egypt, Russia, etc., are in some cases extracted from the shell (as whole eggs or as yolks and whites separately) and sent frozen in tins. "Chilling" to a temperature of 31° or 32° F. is also used.

FISH

Most of the important sea fisheries of the world are found in temperate waters. Fish require broad expanses of shallow sea, suitable for spawning grounds, where the food supply—in the form of plankton or minute animals and plants—is abundant. The great fisheries are therefore restricted to regions where there is a broad continental shelf. There are four regions in the world of paramount importance:

(1) The North Pacific Coast of Oregon, Washington, British Columbia, and Alaska.

(2) The North Atlantic Coast of Labrador, Newfoundland (including the Great Banks), Canada, and the New England States.

(3) The coasts of North-Western Europe, including the North Sea.

(4) The coasts of Japan.

The North Pacific Coast.—The great speciality of the fishing industry is the catching of salmon for export in tins (canned salmon). It is pursued chiefly in the rivers and creeks of Alaska, on the Fraser, Skeena, and Naas Rivers and the numerous inlets in British Columbia and in the Columbia and Sacramento Rivers of the United States. Great fears are being expressed as to the possible exhaustion of the fisheries, in view of the stupendous numbers landed annually. The true sea fishes caught along the same coast include cod, halibut, and herring.

The North Atlantic Coast of America.—The value of these fisheries was appreciated very soon after the discovery of America. The fisheries on the great banks south of Newfoundland are open to all, but the rights of "inshore" fishing are limited by treaty. The principal fish caught are cod, haddock, and herring. Lobsters are important along the coasts south of the St. Lawrence.

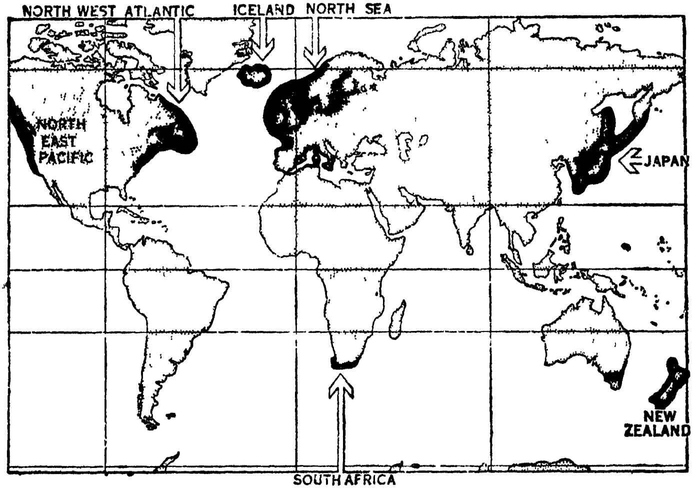

FIG. 132.—Map of the World showing fisheries.

North-Western Europe.—These fishing grounds extend from Lapland to the coast of Morocco, and include the coasts of Iceland. But the most important area is the North Sea. Inshore fishing rights are reserved, but the main North Sea grounds are shared by British, Norwegian, German, Dutch, and other fishermen. British fisheries support, in all, about a million of the population. In 1933 1,000,000 tons of fish were landed, valued at £16,000,000. About 50 per cent. are herring, 15 per cent. cod, and 10 per cent. haddock. Hake are important off the west coasts of Britain, pilchard in the south-west, and plaice in shallower waters. The principal Norwegian fisheries are those of cod and herring, the cod being particularly abundant round the Lofoden Islands.

The fisheries of France, Spain, and Portugal are especially for sardines and sprats.

The Coasts of Japan.—The Japanese fisheries are of greater value than those of any European country even including Britain. Herrings, haddock, and sardines are abundant as well as other food fishes, such as the bonito, not found in the other areas.

Other Fishing Areas.—Other important areas include the Western Mediterranean (sardines, anchovies, and tunny); New Zealand and South-Eastern Australia; Cape of Good Hope; Great Lakes of North America (whitefish).

Oysters flourish in tidal estuaries, especially in the inlets on the Atlantic coast of North America, the mouths of the Thames and Rhine in Europe.

Trade in Fish.—Trade in fresh fish has been steadily expanding the last few years owing to the perfecting of methods of brine freezing, but there is still a very large trade in preserved fish. The value of the export of canned salmon from the United States in 1929 was $7,406,000 [1]—equal to nearly a seventh of the total canned salmon. The total catch of all fish in the United States is estimated to be over 1,000,000 tons per year. About 60 per cent. of the produce of the Canadian fisheries is exported—mainly to the United States. Huge quantities of dried and cured cod are exported from Norway, Great Britain, and America, especially to Roman Catholic countries (Spain, Portugal, Italy, and South America). In 1913 five-sixths of the British herring catch was exported—mainly to Germany and Russia—and in 1930-34 33 per cent. of the total British catch of fish. Details of the trade will be found under the leading countries (see Part II).

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[1] 1933 only $3,200,000.

EXERCISES

1. Make a list of the principal meat-exporting countries. Show against each the weight and value in the latest year for which figures are available. Distinguish between beef, mutton, and pig meats. Figures may be taken from the *Statesman's Year Book.*

2. Attempt to estimate the value of the world's fisheries by collecting together all available figures from the *Statesman's Year Book.*

3. Complete the diagrams, Figs. 120, 124, 127, and 130, from the *Year Book of the International Agricultural Institute.*

4. Draw diagrams to show world trade in hides, collecting figures from the *Statesman's Year Book* or the *Annual Report on the Balance of Trade* (*League of Nations*).

EXAMINATION QUESTIONS

1. Write a comparative account of the dairying industry in the Alps and Holland. (*Univ. London B.A. Hons. Econ. Geog.*, 1927.)

2. What changes do you anticipate in the near future in the world trade in beef?

3. Give some account of the world's chief meat-producing areas, and add any suggestions that may occur to you as to the possible development of important grazing ground in the future. (*Univ. London Inter. B.Sc.* (*Econ.*), 1923.)

CHAPTER IX

THE RAW MATERIALS OF THE TEXTILE INDUSTRIES

After food and drink, the first need of civilized man is clothing. In cooler climates clothing is essential as a protection against the elements, only in tropical lands can clothing be regarded as other than a strict necessity. Advancing civilization generally results in a small increase in *per capita* consumption of food as well as a marked increase in the variety of foodstuffs, but with clothing there is a huge increase not only in variety but in actual per head consumption. A comparison between a negro of the States and one in his home in the African wilds makes this statement obvious. The increased use of clothing with an increase in the standard of living is very marked in India, China, and other thickly populated countries of the tropics and sub-tropics.

Apart from a limited use of skins, leather and rubber, nearly all clothing is made from fibres of either animal or vegetable origin. In quantity cotton and wool are easily the most important, and the enormous increase in the consumption of cotton (even more than wool) in the last century is the obvious result in the upward trend in the standard of living to which reference has just been made.

The leading textile materials are indicated in the following table:

Raw material	Production in metric tons				
	1909–13	1925	1929	1933	1937–8
Raw cotton (ginned)	4,760,000	5,960,000	5,670,000	5,570,000	8,800,000
Wool (in the grease)	1,475,000	1,325,000	1,640,000	1,670,000	1,670,000
Flax	718,000	656,000	663,000	680,000	770,000
Silk	110,000	150,000	220,000	200,000	200,000
Artificial silk	—	80,000	186,000	300,000	510,000
Jute	1,532,000	1,419,000	1,768,000	1,430,000	1,575,000
Hemp	545,000	726,000	773,000	470,000	410,000

Of these, the last two are but little used for clothing.

COTTON[1]

The raw cotton of commerce consists of the innumerable small hairs which clothe the seeds of the cotton plant. When the fruit or " boll " of the plant is ripe it bursts open and exposes a white fluffy ball consisting of the seeds and their enveloping hairs. The whole ball is picked and the seeds separated from the cotton fibre by the process known as ginning.

The Cotton Plant.—The cotton plant is a small shrub belonging to the genus named by botanists *Gossypium,* of the natural order *Malvaceæ.* Several species have been described; for convenience we may distinguish four groups:

(*a*) *Gossypium herbaceum,* the Asiatic cotton, found in India, China, and Asia generally, has short rather wiry hairs (short-stapled).

(*b*) *Gossypium hirsutum,* the American cotton, is closely allied to the last but has longer and less wiry hairs.

(*c*) *Gossypium barbadense,* the Sea-Island cotton, probably a native of Barbadoes, is the finest of all cottons.

(*d*) *Gossypium arboreum* (or *Gossypium peruvianum*), the tree cotton of South America, forms a woody tree 10 to 15 feet high and fruits for ten years or more.

Although the first three are small shrubs they are usually grown as annuals, that is are grown from seed every year.

Conditions of Growth.—The cotton plant grows best on rich, light, well-drained soils, but does fairly well on comparatively poor soils. The soil must be capable of retaining moisture and it is this characteristic which renders the sticky, " black cotton soil " of India so suitable for cotton. The plant requires plenty of moisture in the growing season—a hot, moderately damp but not saturated atmosphere with frequent showers—until the flowers are formed and then a dry, sunny period until the bolls ripen and burst and the cotton can be gathered. The plant is particularly susceptible to frost; the date of planting of the seeds is determined by the last " killing frost " of spring, the cotton should be gathered before the " killing frosts " of autumn. Two hundred frostless days—a little over six months—may be taken as the normal requirements. In the United States the annual rainfall line of 23 inches marks the western limit of the cotton belt, but most of the cotton region has rather over 40 inches of rain. In India the native cotton grows with a rainfall of between 20 and 40 inches, but in both India and Egypt the best cotton is on irrigated land in drier regions. The climatic requirements for cotton are satisfied especially by the warm Temperate Oceanic Climate (Gulf type and China type) as well as by the Tropical and Monsoon Climates (drier parts). The actual and potential cotton lands of the world thus lie roughly between 30° S. and 40° N., excluding the belt of equatorial climate.

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[1] I am greatly indebted to Mr. J. A. Todd, Principal of the Liverpool School of Commerce, for invaluable assistance in revising this section.

Cotton is an exhausting crop and after a limited number of years manuring, or a carefully regulated crop-rotation, becomes essential. In all the older cotton areas of the United States along the Atlantic Coastal Plain, the annual expenditure on fertilizer is now large. Cotton seed is a valuable oil seed and after the oil has been expressed the rest makes excellent cattle cake.

The cotton plant is very liable to disease. The most serious is that caused by an insect pest, the Mexican cotton boll-weevil. Entering Texas from Mexico in 1892 it spread rapidly year by year until it had ravaged the greater part of the American cotton area, and strenuous measures are desirable to keep it in check.

Cotton is picked by hand; automatic cotton-picking machines have not yet supplanted hand labour. The cotton must be picked as soon after the boll has burst as possible, otherwise rain, dust, and mud combine to ruin the crop. There is thus an immense and relatively sudden demand for labour just at the time of harvest, and the supply of cheap labour is an extremely important factor in successful cotton cultivation. The average native labourer is capable of picking at least 100 lbs. of seed cotton per day.

Production of Commercial Cotton.—The seed-cotton as brought in from the fields has first to be subjected to the process of "*ginning*" to separate the seed from the "lint" or fibre. Prior to the invention of the saw-gin in 1793 it would have taken many months for one man to "gin" a modern bale of 500 lbs. After ginning the raw cotton is compressed into bales, averaging about 500 lbs. each. The elastic fibres of cotton, unlike those of Kapok which has been suggested as a substitute, are uninjured by this compression into bales. It is in the form of bales that raw cotton enters the international trade channels. An essential process in manufacture is *carding*. In carding the little fibres are teased out into a soft untwisted rope or sliver in which all the hairs are parallel. This process is now performed by teethed bands passing over rollers; formerly in the analogous process with wool the delicate hooked spines of the thistle-like teasle heads were used, hence the term carding (from Lat. *carduus* = a thistle). In the process of spinning the fibres are twisted into threads (forming yarn). Weaving, the actual making of cloth, is a distinct process.

Raw cotton varies enormously in quality. The important factors determining quality include length and regularity, fineness, lustre, softness, strength, colour, and cleanness. The little hairs vary in length from about ½ inch to 2¼ inches. In America, when the hairs are less than ⅞ inch in length the cotton is referred to as short stapled. In Egypt only cotton exceeding 1⅛ inch would be called long-stapled. In other countries the terms are relative. We may classify the various grades of raw cotton into four principal groups :

Grade I (above 1⅜ inches staple). The best of all is the very small crop of Sea Island—a fine silky cotton—grown in the West Indies. Attempts are now being made to revive the growth of this variety in Georgia and Florida, where it was grown in larger quantities till the advent of the boll weevil. The best varieties of Egyptian cotton grown in Egypt and the Sudan and a little in Arizona from seed originally Egyptian also come into this grade.

Grade II (above 1⅛ inches). The bulk of the Egyptian crop (Uppers) and the Peruvian, also certain Brazilian varieties (North Brazil), East African (Uganda and Tanganyika), and the best varieties of American long staple. A good deal is now grown in Russia.

Grade III (⅞ inch to 1⅛ inches). The bulk of the world's supplies, including the American crop, most of the Brazilian (Sao Paulo), other South Americans (*e g.* the Argentine), the Russian and part of the Chinese, other African crops and about one-third of the Indian crop.

Grade IV (below ⅞ inch). The remainder of the American and Indian crop, and probably the bulk of the Chinese and other Eastern and Near Eastern crops. Many of these are harsh in character as well as short-stapled.

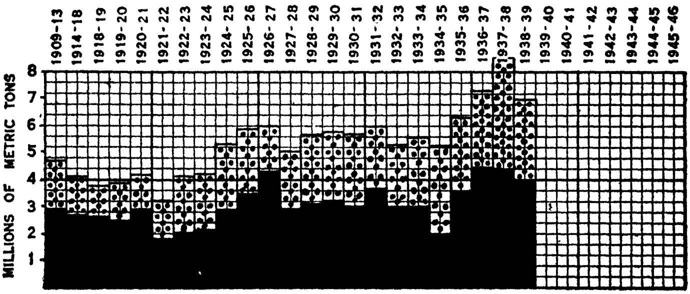

FIG. 133.—World production of cotton in recent years, excluding certain countries for which definite figures are not available, and which produce in all about 80,000 tons (U.S.A. in black).

World Production of Cotton.—Fig. 133 shows the remarkable fluctuations in world production in recent years. The black portion, representing the output of the United States, shows the dominating importance of the United States production. In the space of five years the prospect of an imminent cotton famine, which seemed to be foreshadowed by the very low world production of 1921–23, had been changed into the big production in 1926–27, when it was feared that destruction of many thousands of bales would have to be resorted to. Fig. 134 shows at a glance that there are only four really large cotton producers—the United States, India, China, and Egypt. To these may be added Russia, for which figures were not available in drawing Fig. 134. Of these India produces mainly coarse, short-stapled cotton unsuited to European requirements; China produces coarse cotton for local use; in Egypt, the available area in the narrow Nile Valley and in its delta is strictly limited. The United States is using an increasingly large proportion of her production at home, and as long ago as 1902 British manufacturers combined to encourage production of cotton within the British Empire. Many parts of the British Empire are capable of becoming big producers: in many cases the labour difficulty is the most serious one, in others transport. Fig. 135 shows most of the countries now producing whilst the table given below shows the output. The progress of most of these new producers was temporarily checked by the heavy U.S. output of 1926-27. The wide expansion which is possible must be emphasized.

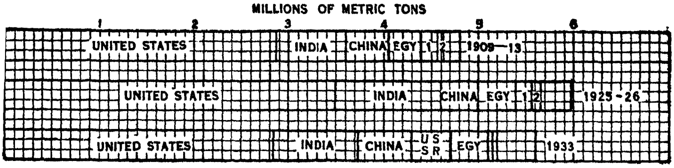

FIG. 134.—Production of cotton in the principal producing countries.

1 = Mexico; 2 = Brazil Multiply by 4·4 to convert metric tons to bales. Notice the small production of all the remaining areas Russia produces about 400,000 tons.

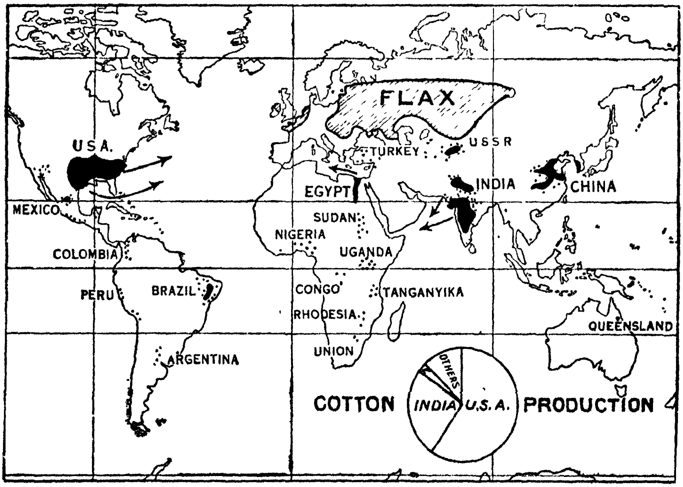
FLAX
U S A.
MEXICO
COLOMBIA
PERU
BRAZIL
ARGENTINA
TURKEY
U S S R
EGYPT
INDIA
CHINA
SUDAN
NIGERIA
UGANDA
CONGO
TANGANYIKA
RHODESIA
UNION
QUEENSLAND
COTTON
INDIA
U.S. A.
OTHERS
PRODUCTION

FIG. 135.—Map of the World showing cotton-growing countries.

The "wheel" diagram at the base *excludes* China.

Cotton production is usually quoted in "bales." These are normally of 500 lbs. gross; Indian and Empire bales are, however, only 400 lbs., whilst Egyptian are 750 lbs. Roughly 4·4 bales = 1 metric ton.

PRODUCTION OF RAW COTTON IN METRIC TONS
(Multiply by 4·4 to get approximate number of bales)

Country	1909–13	1925-26	1937–38
Europe—	*4,800*	*5,100*	*32,000*
Greece	3,310	3,167	16,700
Italy	1,130	980	4,200
America—	*2,991,700*	*3,753,000*	*4,835,000*
Colombia	1,206	3,450	—
United States	2,825,819	3,491,551	4,105,200
Haiti	2,009	4,995	5.400[1]
British West Indies	1,124	840	—
Mexico	43,698	43,851	73,700
Argentina	637	29,220	61,000
Brazil	90,711	130,421	478,000
Paraguay	20	2,489	9,000
Peru	26,082	44,298	91,900
Asia—	*1,466,100*	*1,776,090*	*1,918,000*
China	482,515	457,900	700,000
Korea	4,198	26,715	46,100
British India	777,000	1,127,600	1,027,500
Indo-China	2,992	2,380	1,300[2]
Japan	765	338	200[2]
Persia	24,029	18,133	37,200[2]
Syria	—	2,910	5,600
Turkey in Asia	22,141	22,803	60,000
Asiatic Russia	196,200	158,890	819,000
Dutch East Indies	3,955	1,186	1,300[2]
Africa—	*326,500*	*431,000*	*694,000*
French West Africa	—	8,204	3,700[1]
Algeria	297	1,211	100
Egypt	314,978	357,836	494,700
Nigeria	2,015	8,692	8,900[1]
Uganda	4,409	32,814	62,800
Anglo-Egyptian Sudan	3,134	23,083	55,700
Belgian Congo	—	3,500	31,500[2]
Nyasaland	1,093	1,400	1,800
Rhodesia	—	1,324	—
Tanganyika	1,728	3,932	11,700
Union South Africa	16	3,700	700[2]
Australia—	*200*	*2,100*	*2,000[2]*
Australia	16	1,232	1,900
Grand Total	**4,789.300**	**5,966,700**	**8,300,000**

British Empire and Egypt about 28 per cent. of the whole in 1925–26. [1] 1935. [2] 1936. The production in 1937–38 was exceptionally high.

The Principal Cotton-growing Countries.—*United States.*—The cotton-growing area of the United States corresponds roughly with the area already delineated as having the "Gulf Type" of climate. It is bounded on the west by the 23-inch isohyet; on the north by the line of 200 frostless days. The latter line corresponds closely with the summer isotherm of 77° F. The southern part of Florida may be excluded from the cotton area. Cotton takes second place in value amongst the crops of the United States, but ranks first as a " cash " or commercial crop. The United States has a more dominant position with regard to world supplies of this commodity than of any other. In the early days of the industry, production was concentrated in the States of the Atlantic Coastal Plain, it has gradually moved westwards so that Texas is now the largest producer. The advent of the boll-weevil moving gradually, year by year, northward and eastward, left behind it a diminished cotton production. Largely owing to the varying influence of the pest, acreage in the Atlantic States dropped, and has only recently started to recover. The bulk of the cotton grown is the ordinary short-stapled upland; long-stapled upland grows in the Yazoo Delta and in South Carolina; the sea-island, formerly grown along the coast of South Carolina, Georgia, and Northern Florida, has been almost entirely eliminated by the boll-weevil. Outside the main cotton belt there is the irrigated land of the Imperial Valley of Southern California, and the Salt River Valley of Arizona, where Egyptian and long-stapled upland both grow well. The absence of cotton in Southern Florida and along the Gulf Coast should be noted—they have too much rain in autumn and only swampy or poor sandy soils. The centres of heaviest production in the cotton belt are determined mainly by soil conditions. There is the " Black Prairie " of Alabama and North-Eastern Mississippi, the Yazoo " bottoms " along the Mississippi, and the " Black Prairie " region of Texas. The heavy production areas in the Atlantic States are largely due to the use of fertilizers. Although the ravages of the boll-weevil encouraged the growing of other crops, cotton is easily the leading crop in the cotton belt,

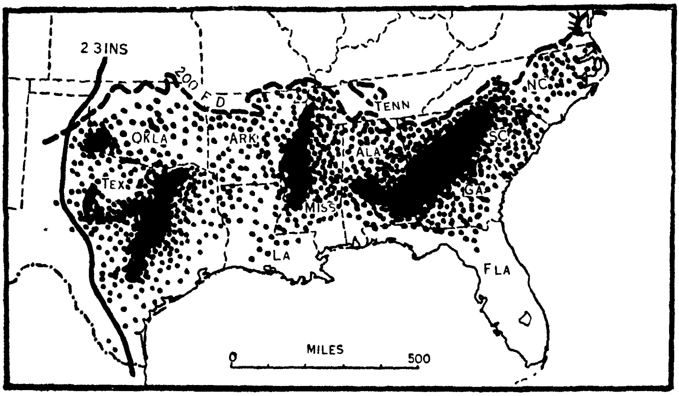

FIG. 136.—The cotton lands of the United States.
The dotted line (200 F.D) marks the line of 200 frostless days.

occupying more than half the cropped land. Corn is the second crop. In the last 35 years the yield of cotton has varied from 124 lbs. per acre (1921) to 209 lbs. per acre (1914). Prior to the war two-thirds of the crops were exported. The proportion is now a little over half, owing to the development of home manufactures, but naturally fluctuates widely according to the surplus available. There has been a marked decline in the proportion taken by Great Britain, whilst an increasing proportion has gone to Japan and Canada.

India.—As will be shown in the section on India in Part II, cotton in India may be called a "Dry-Zone" crop. It is very largely restricted to the area with less than 40 inches of rainfall. There are three leading centres of production:

(*a*) The black cotton soil of the north-western part of Peninsular India, forming the hinterland of Bombay. The sticky, moisture-retaining soil is suited to the growth of native cottons mainly of short staple. The yield is generally low—less than 100 lbs. per acre.

(*b*) The fertile alluvium of the Indus and Ganges plains. When irrigated the American cottons, greatly superior to the native varieties, grow well.

(*c*) The ferruginous soils of the South of India which, in parts of Madras, grow cotton of excellent quality.

An increasing proportion of India's cotton is being consumed by home mills, especially at Bombay, but there is a large export to Japan and Southern Europe. Indian cotton is not, as a rule, sufficiently good to meet the requirements of Lancashire manufacturers. Geographically it is interesting to note that, although cotton is exported in large quantities through both Bombay (rainfall 80 inches) and Karachi (rainfall 10 inches), owing to the dryness of the atmosphere cotton mills cannot be established at Karachi to rival those of Bombay.

Egypt.—Egyptian cotton is, like other crops, grown in the delta and narrow valley of the Nile, on land irrigated by that river. There is little room for expansion of acreage; increase in production is only possible by increasing the yield per acre. The yield per acre is very high, averaging about 300 lbs., and has been higher. Of recent years the "Sakel" or Sakellaridis variety, with a staple of 1¼ to 1⅝ inches, has become very popular and now accounts for a large proportion of the whole.

South America.—In Brazil both herbaceous and tree cottons are grown. The tree cotton has very large bolls and gives a good yield for three or four years. The tree seems to be comparatively immune from insect disease. Peru is also an important producer of cotton, and is specially interesting because of a special crinkle variety ("Rough Peruvian") which mixes well with wool.

Africa.—Leaving aside Egypt, which we have already considered, the great stretches of Tropical Grassland (see map, Fig. 39) on the African plateau form the most important areas for future cotton supplies. Development is controlled by economic rather than by climatic or edaphic factors. Two courses are open:

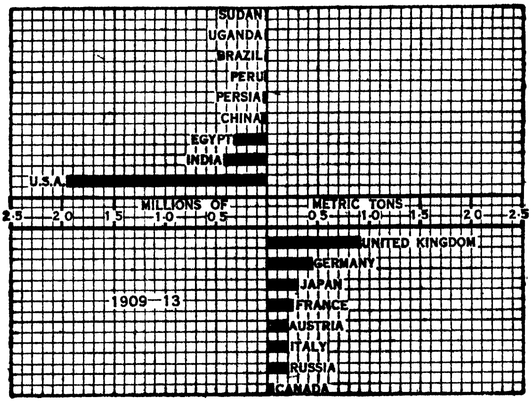

Fig. 137.—World trade in cotton, 1909–13.

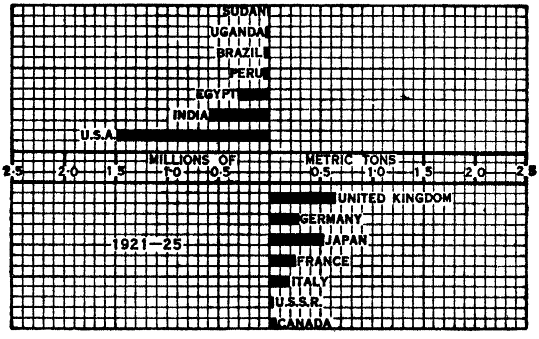

Fig. 138.—World trade in cotton, 1921–25.

(*a*) The encouragement of native cultivators.

(*b*) The establishment of large plantations owned and supervised by Europeans.

In the latter case the main difficulties are transport, labour supply, and overhead charges—especially the cost of European supervision. After investigation by the British Cotton Growing Association schemes for European owned or managed plantations have been virtually abandoned. At present the most important progress has been made (as shown by the table above) in Uganda, where cotton is the leading export, the Sudan, Nigeria, Tanganyika, and Rhodesia. A considerable quantity is grown in the Union of South Africa.

Australia.—Considerable tracts of tropical Australia, especially in Queensland, are suited to cotton. Under the White Australia policy the principal difficulty is one of labour supply.

Asia.—Outside of India, China has a large production for home use; more than half is probably used by the old hand looms in the villages, and for wadding in padding winter clothes. China's total production, coming mainly from the Yangtze and Hwang-Ho valleys and the Great Plain of Northern China, probably exceeds that of India. In Russia native cottons are grown, especially in Turkestan. Mention must be made of the possibility in Iraq of developing irrigation by the Tigris and Euphrates and growing cotton as in the Nile Valley or on the Indus Plains.

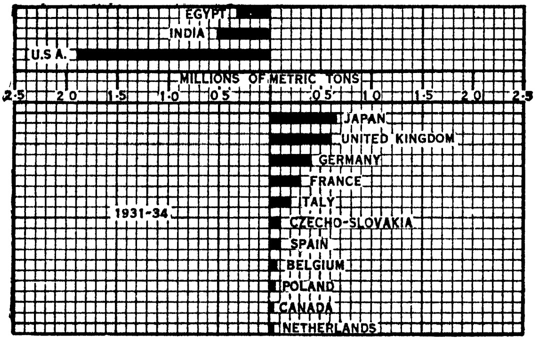

FIG. 139.—World trade in cotton, 1931–34.

Despite possibilities for the future, emphasis must be placed on the evidence afforded by Fig. 133 of the present slight output of all the "small producers" combined.

World Trade in Cotton.—Considerably more than half the cotton grown in the world enters into international commerce. Figs. 137 and 138 can be left to speak for themselves.

Using the average price of American middling at New Orleans of 11 cents per lb. (the 1934 average) the world trade in 1929 was of the order of $735,000,000. Taking the Liverpool price of 7*d.* per lb. for the same quality (rather below 1934 actual prices) the world trade would be roughly £200,000,000 in value in 1954. These figures are far below earlier years.

Cotton Manufacture.—The cotton manufacturing districts of the world cannot here be discussed in detail, but some of the leading areas may be mentioned. The relative importance of an area is often gauged by quoting the number of spindles for spinning, though the average consumption of raw cotton per spindle varies greatly. In Great Britain the industry is localized in South-East Lancashire with over 40 per cent. of the world's spindleage and about two-thirds of the world's "mule spindles" necessary for the finer qualities. Liverpool is the seat of the chief raw cotton market (Liverpool Cotton Exchange); Manchester has a smaller market. In America the location of the cotton towns was originally determined by the presence of water-power in the New England States. of recent years there has been a marked tendency to the development of cotton manufacturing in the cotton belt itself. Bombay is the Indian centre; Osaka the Japanese centre; Shanghai, Hangchow and Ningpo the principal modernized cotton-mill towns of China. On the Continent of Europe the cotton-manufacturing towns are scattered, and their position has been determined by several factors. This is well seen by studying the rise of Lille, Rouen, and Amiens in France. German centres are Barmen-Elberfeld on the Ruhr Coalfield, and Chemnitz on the Saxon Field. Hydro-electric power has been an important factor in cotton manufacturing development in Italy and Switzerland.

WOOL

Of all the animal fibres used in the textile industries the most important is the wool of the domestic sheep. There is no wild sheep with a fine fleece and the sheep was domesticated at an early date in the civilization of man. Sheep are now the most numerous of all domestic animals.

The fibres of wool differ from those of cotton in being covered with tiny overlapping scales. The presence of these scales accounts for the "felting" properties of wool; the fibres can be beaten together into a fabric (felt) without weaving. The fibres of wool are finely curled or crimped and a woollen cloth therefore includes a large proportion of air space. Air is a bad conductor of heat, and thus woollen clothes with their large amount of included air are very warm. Woollen clothing is extensively used in nearly all temperate countries except China and Japan.

Conditions for Sheep-Rearing.—Reference has already been made to the conditions required for the rearing of sheep for mutton. For the production of wool, sheep require a cool, dry climate without extreme cold. The Temperate Grasslands of the Southern Hemisphere are thus eminently suitable; those of the Northern Hemisphere suffer from too great a cold in winter to form ideal sheep country. Thus at Dubbo, in the Australian sheep-rearing regions the temperature ranges from 47° F. in July to 79° in January; at Graaf Reinet in South Africa from 51° in July to 72° in January. Wool-sheep thrive on comparatively poor herbage. With a rainfall of less than 10 inches, growth of grass or other fodder tends to become inadequate; with a rainfall of much over 30 or perhaps 40 inches the grass tends to become too luscious and the sheep suffer from foot rot and other diseases. Although dry conditions favour production of wool, the stock tends to become impoverished and may need to be replenished by strong, healthy animals from cooler, damper regions. Thus Australian sheep runs are replenished to a considerable extent from Tasmanian flocks.

Wool-bearing sheep fall into three main groups:

(*a*) Original English breeds. In the Middle Ages wool was not only an important product but a leading export of England. The English breeds have become widespread in South Africa, Australia, and New Zealand.

(*b*) Merino sheep. These sheep are natives of North Africa, but were introduced into Spain and other grassy areas in Mediterranean lands in the Middle Ages and later into Saxony. They yield but very poor meat and are bred essentially for their wool. They have become very important in South America, South Africa, Australia, and New Zealand.

(*c*) Cross-bred sheep. These sheep are derived from cross-breeding between merinos and English strains. A large proportion of the Australian and New Zealand flocks are cross-bred. Cross-bred sheep yield both meat and wool.

Production of Commercial Wool.—(*a*) *Shearing.*—Shearing by machinery is now usual at most large sheep stations, and as the quality of the wool varies considerably from one part of an animal to another, the fleeces are usually clipped round or "skirted," the inferior clippings being thrown into a separate bin. According to the age of the animal four grades of wool are distinguished:

(*a*) Lamb's wool from 7 months' old animals—the finest.
(*b*) Hoggetts from 12 to 14 months' old sheep.
(*c*) Wether wool from sheep of all other ages.
(*d*) Double fleece, representing two years' growth, is poorer in quality than a single-year fleece from the same animal and is cheaper.

Fleeces vary greatly in weight. Australian sheep average between 5½ and 7 lbs.; New Zealand sheep 7½ lbs. A prize fleece may be as much as 30 or 40 lbs.

Wool is graded according to the "count" or number of 560-yard hanks that weigh 1 lb.

(*a*) Fine counts, from 60 to 90 hanks to 1 lb. These are chiefly merino wools and are short stapled (2½ to 6 inches).

(*b*) Medium counts, from 36's to 60's. These wools are usually long stapled (up to 12 inches) and include the wools of English breeds and the cross-bred Colonial wools of South America and Australia.

(*c*) Coarse or low counts, below 36's. These wools are more like hair, and include the wools of Southern Russia, Asia, and North Africa.

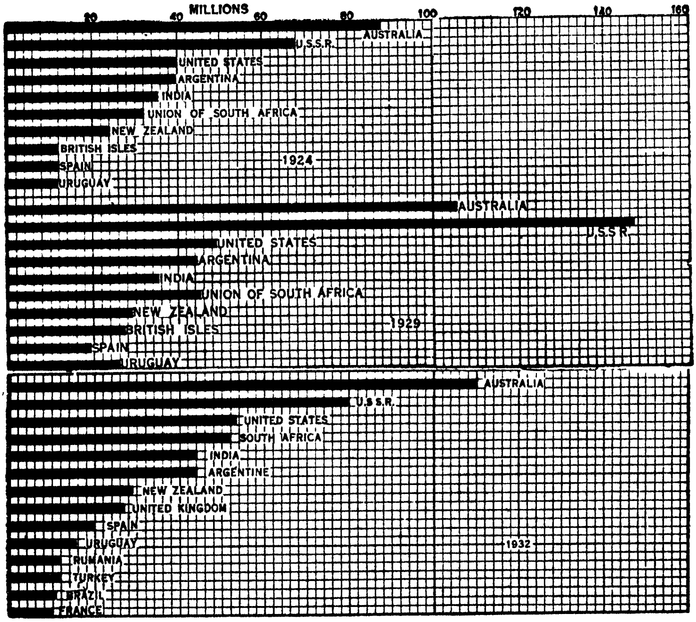

FIG. 140.—The principal flocks of sheep in the world.

Wool as shorn from the sheep contains a large proportion of grease called "yolk" as well as varying proportions of dirt. It is usually exported "in the grease" and productions are quoted on a "greasy" basis. The wool may be washed to remove dirt, but if the grease is removed the wool felts or mats together.

(*b*) *Scouring.*—The wool is washed with water containing ammonia or some solvent to remove the grease. Greasy wool loses half its weight when scoured. The grease extracted is known as lanoline and is used in the preparation of toilet soaps. It should be noted that wool taken chemically from pelts is called "slipes."

(*c*) *Carding or Combing.*—Formerly it was usual for long stapled wools to be combed out and then spun into worsted yarns. "Tops" is the technical term for the long hairs; "noils" are the short hairs combed out. Short-stapled wools were "carded" (as with cotton) and spun into carded or clothing yarns suitable for "milled" or "fulled" cloth. According to modern practice some short-stapled wools can be combed so that "combing wools" are not necessarily long-stapled or "carding wools" short-stapled.

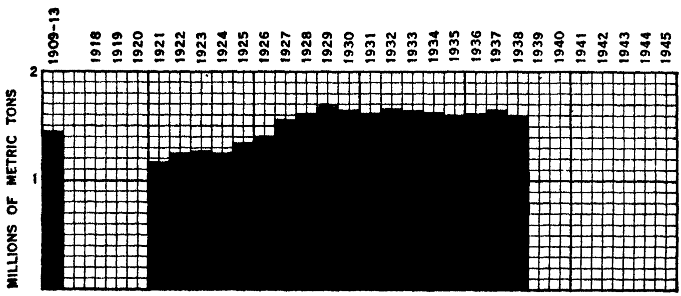

FIG. 141.—World production of wool.

(*d*) *Weaving.*—There are two main groups of cloths made from wool: (1) worsteds, in which the individual threads may be distinguished; (2) woollens, in which the surface is "milled" so that the individual strands are no longer to be distinguished. A blanket is a good example of the latter.

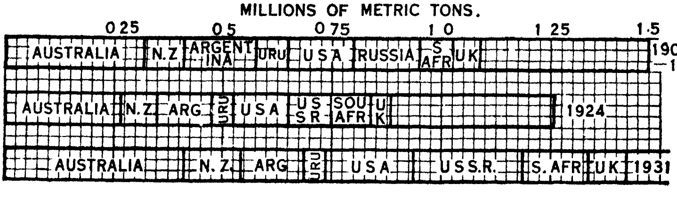

FIG. 142.—Production of wool in the principal producing countries, calculated on a "greasy" basis.

Each small division of the lateral scale represents 55,000,000 lbs. of greasy wool.

World Production of Wool.—Fig. 140 shows the variation in number of sheep within recent years; Fig. 141 the variation in wool production. In Fig. 142 the important place occupied by the Temperate Grasslands of the Southern Hemisphere should be noted.

The Principal Wool-producing Countries.—*Australia.*—Sheep breeding for wool is the principal pastoral industry of Australia. Wool to the value of £60,000,000 was produced in 1928–9[1] (which may be taken as typical) and roughly 85 per cent. is exported. Sheep are practically restricted to temperate Australia where the rainfall is between 10 and 30 inches. Nearly half the sheep are in New South Wales. Although Australia has the largest flock of sheep in the world—112,000,000 in 1932—exceeding the total of 106,421,000 reached in 1891 when, however, many of the runs were overstocked. The number of sheep and the production of wool in Australia fluctuate in a marked way with the rainfall. Enormous numbers of sheep perished in the great droughts of 1901–2 so that the number of sheep dropped to 54,000,000 in 1902.

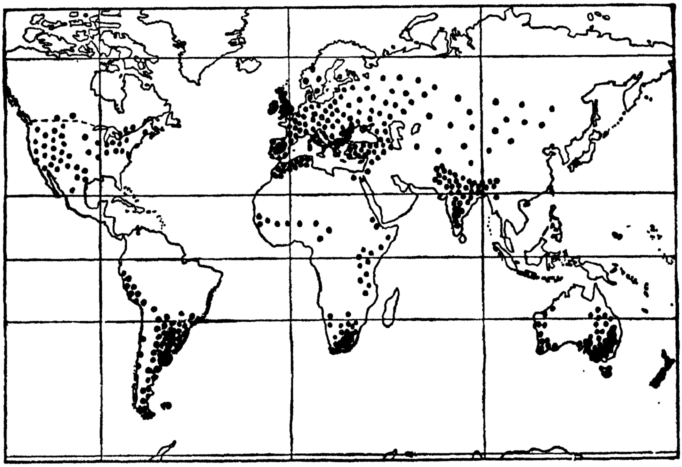

FIG. 143.—Map of the World showing distribution of sheep.

Notice the marked concentration in the temperate regions and especially in the temperate grasslands of the Southern Hemisphere.

At present attention is being paid to the breeding of animals to yield both meat and wool.

The greater part of the Australian wool clip is sold before export. In pre-war years about 31 per cent. went to the United Kingdom; in recent years more than 50 per cent.[2] Other large customers are France, Belgium, the United States, and Japan.

New Zealand.—The varied topography of New Zealand affords varied habitats suited to different breeds. Merino sheep thrive on the hills of the South Island; Romney sheep from the Romney marshes of Southern England thrive in the moister North Island.

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[1] Dropped to £39,000,000 in 1933.

[2] Now 30–35 per cent.

The famous Coriedale Breed (cross between merino ewes and Leicester or Lincoln rams) thrives on the dry Canterbury Plains.

South Africa.—Sheep breeding is the oldest and most important agricultural or pastoral industry of South Africa. The original fat-tailed Cape sheep have been interbred with imported merinos, English breeds, and later with Australian stock. As in Australia the number of animals fluctuates somewhat according to the seasons. The majority of sheep are on the High Veld where the rainfall is between 20 and 40 inches.

South America.—The River Plate wool from Argentina and Uruguay (rainfall between 20 and 40 inches) is not so highly esteemed as Australian or South African. It is dirtier, and goes mainly to France, Belgium, and Germany.

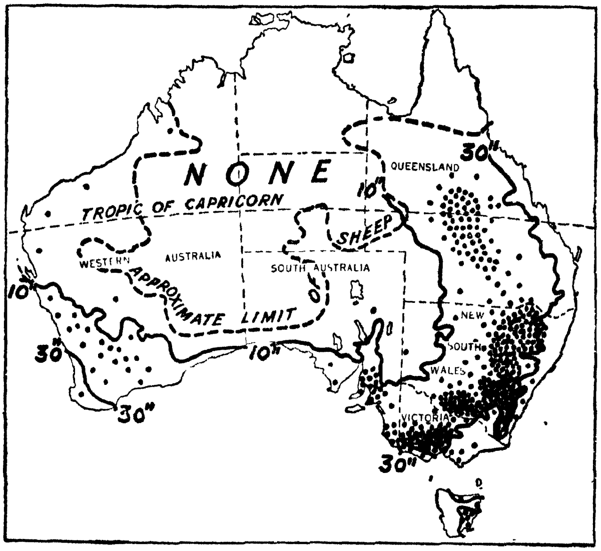

FIG. 144.—Sheep lands of Australia, showing "climatic control."

Nearly all the sheep are found between the isohyets of 10″ and 30″ and nearly all in the temperate zone. Each dot represents 250,000 sheep (1924).

North America.—Although the second largest wool-growing country, the United States produces only about half her wool requirements. Texas, Wyoming, and Montana are the leading states. The home wool is poor, but has recently been improved by cross-breeding. Imports are derived from Australia, China (carpet wool), Argentina, British India, New Zealand, and the United Kingdom. In Canada the prairies are too cold for sheep. Southern Ontario and Southern Quebec form the principal sheep-rearing area.

Europe.—Sheep are numerous in most European countries, but the supply is insufficient to meet requirements. England, once an important exporting country, still has large flocks and still exports a certain quantity of wool of a particular type mainly to the United States, but has a huge import from Australia, South Africa, and New Zealand.

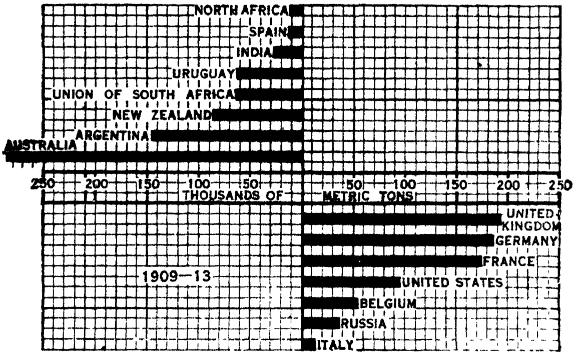

FIG. 145.—World trade in wool, 1909–13.

Asia.—Indian and Chinese wools are poor in quality and useful mainly as carpet wools.

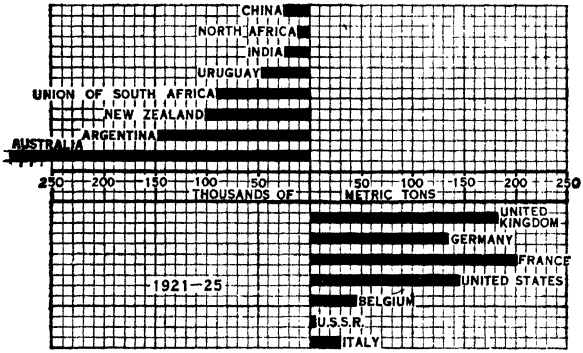

FIG. 146.—World trade in wool, 1921–25.

World Trade in Wool.—World trade is summarized in the diagrams, Figs. 145 and 146.

Other Wools and Hairs.—Although including some of the finest of textile materials, the rarer animal fibres are usually handled by dealers specializing in "low wools."

Mohair is obtained from the Angora goat and is an important export from South Africa. There the goats flourish on the Karroo, where it is too dry for sheep. Mohair makes strong, lustrous materials, such as plushes.

Cashmere is the fine, downy winter undercoat of the Kashmir (or Cashmere) goat, a native of Kashmir, Tibet, and Southern China. Each fleece yields only about 3 oz.

Camel's hair is obtained mainly from China and Turkestan. The mane and hump produce strong hair, the remainder of the body downy "wool."

Alpaca, llama, vicuna, and guanaco are all animals native to South America, especially on the high Andes of Peru. The wool of the vicuna, a wild animal, is sometimes said to be the finest of all textile materials.

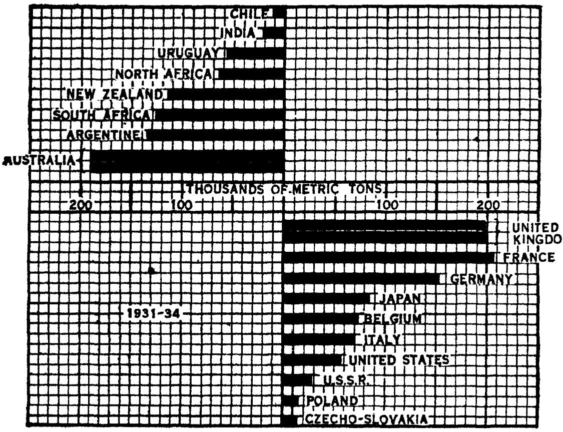

FIG. 147.—World trade in wool, 1931–34.

SILK

Silk is obtained from the cocoon of the "silkworm." The "silkworm" is really the caterpillar stage of several species of moths belonging to the order Bombycidæ. The most important species is *Bombyx mori*, so called because it feeds on the leaves of the White Mulberry, *Morus alba*. When about to become a chrysalis, the caterpillar sends out from two minute apertures in its head two strands of jelly-like material which unite and harden on exposure to the air. The caterpillar completely envelops itself in a cocoon made up of a continuous strand so formed.

Conditions for Silkworm Rearing.—The female of *Bombyx mori* is a sluggish moth which lays about 500 eggs and then dies. The minute eggs are covered with a gelatinous material and are usually washed before being incubated. For incubation the eggs are kept for eleven months at an even temperature of 64° F. The worms are about $\frac{1}{12}$ inch long when hatched, and are born with ravenous appetites. They feed for four days before becoming torpid, bursting their skins and starting afresh. During their brief life of seven weeks the skin is shed four times. Although the worms themselves can be, and are, kept under glass, a genial spring is still of very great importance in providing a continuous supply of fresh mulberry leaves. Each pound of eggs will require about 10 *tons* of leaves, so that every spring the silkworms of the world consume 25,000,000 tons of fresh young mulberry leaves, 30 or 40 trees being needed to yield 1 ton of leaves. If the worms themselves are kept out in the open a minimum average temperature of at least 60° from April onwards is required. When fully grown each caterpillar should be placed by hand on clean straw or twigs in a suitable position. It is unnecessary to emphasize further the skill and patience required at every stage in the production of raw silk. Not only must labour be abundant and cheap but inherited delicacy of manipulation is virtually a necessity. It is this factor which restricts the commercial production of silk to a belt stretching from Japan and China to Spain and Southern France. Climatically the belt lies mainly in warm temperate latitudes and is limited by the conditions necessary for the production of an adequate supply of young mulberry leaves in the spring.

Production of Commercial Silk.—The average cocoon measures about 1 inch by $\frac{3}{4}$ inch and yields from 300 to 500 yards of silk thread. The finest are selected for breeding ; the remainder are killed by stifling in an oven at a temperature of 200° F. or by dry steam. The dead animal is then beaten out in the form of dust, and the cocoon is ready for reeling. The thread from an individual cocoon is too fine for use by itself so that a number of cocoons are reeled off together—five to seven cocoons for fine threads, up to twenty for coarse ones. The threads are sufficiently adhesive to unite. Hand reeling has nearly everywhere given place to steam filature, except in the interior of China. The raw silk is collected into hanks, in which form it is exported. As 100 lbs. of cocoons yield only 9 to 10 lbs. of silk, cocoons are seldom exported. The outer husks, part of the interior, fragmentary cocoons, etc., left after reeling are exported as husks, knubs, or waste and used for spinning cheap fabrics.

World Production of Silk.—Production is sometimes expressed in weight of cocoons, sometimes in weight of raw silk. The one is about $\frac{1}{10}$ or $\frac{1}{11}$ of the other. China is estimated very roughly to produce 400,000,000 lbs. of cocoons, or nearly 200,000 metric tons (1934 estimate), yielding about 40,000,000 lbs. of raw silk. In the other countries of the world Fig. 148 shows the very marked increase in production in recent years. A large part of this increase is from Japan.

The Principal Silk-producing Countries—*China.*—China probably produces more than two and a half times as much silk

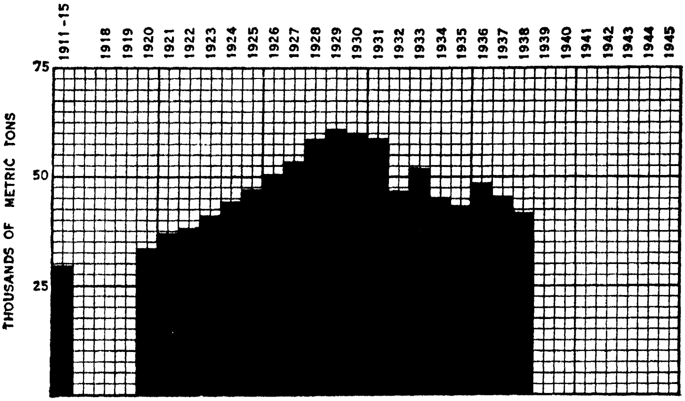

Fig. 148. World production of silk.

The diagram shows the world production of raw silk, except that the figures for China which are included are export figures.

as the rest of the world combined. According to Chinese legend silk was discovered about 2,700 B.C. by Si-ling-she, who has been made a saint by way of reward. The principal silk-rearing areas lie between 30° N. and 35° N. in the Yangtze Basin and in Shantung.

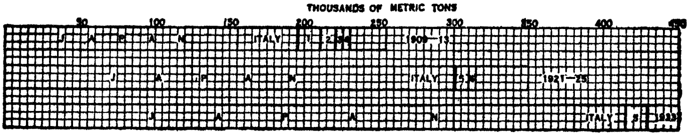

Fig. 149.—Production of silk (cocoons) in the principal countries.

The totals are greater than shown in the last figure, because between 40,000 and 50,000 tons have been allowed for India and other countries for which no exact particulars are available. Not including China.

1 = Turkey; 2 = Russia; 3 = Indo-China; 4 = France; 5 = Korea.

Formerly a fifth of the export was obtained from wild moths and was known as wild silk. In 1894 less than 6 per cent. of the silk exported from China was steam-filature silk; in 1911 the proportion had risen to 60 per cent.

Japan.—Japan is next in production to China. Formerly the yield fluctuated greatly according to the geniality or otherwise of the spring months. This difficulty has been largely overcome and of recent years two "crops" have been the rule—one of spring cocoons, the other of late summer or autumn cocoons—the proportion of autumn cocoons has been steadily rising:

	Spring eggs	Spring cocoons	Autumn eggs	Autumn cocoons
1909–13 . .	52·2 per cent.	60 per cent.	47·5 per cent.	40 per cent.
1925 . . .	43 ,,	48 ,,	57 ,,	52 ,,
1929 . . .	43 ,,	49·6 ,,	57 ,,	50·4 ,,
1933 . . .	45 ,,	49·5 ,,	55 ,,	50·5 ,,

Whilst the yield of silk from spring cocoons is thus still greater than from autumn cocoons, more than half Japan's silk is now obtained from the later crop, safe from the vagaries of spring.

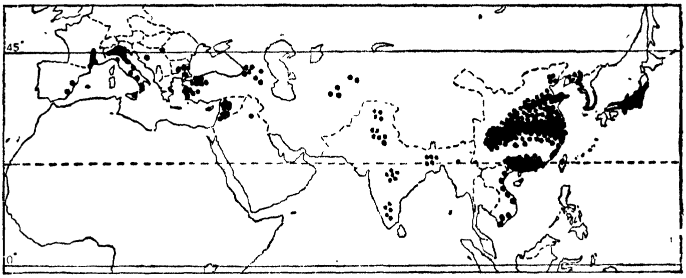

FIG. 150.—Map showing silk-producing countries.

The silk-producing areas should all be carefully identified from the last figure.

There has also been a remarkable increase in yield of silk per unit weight of eggs incubated:

1909–13 . 1 lb or 1 kg. of eggs yielded 1071 lbs. or kgs. of spring cocoons.
,, ,, ,, ,, 796 ,, ,, autumn ,,
1933 . . 1 lb. or kg. of eggs yielded 2320 lbs. or kgs. of spring cocoons
,, ,, ,, ,, 1918 ,, ,, autumn ,,

India.—Despite the fame of Indian silk goods, sericulture in India is in a relatively moribund condition. There are many varieties of "wild" silkworms, including the caterpillar of the Tasar moth from which the name Tasar or Tussore silk was originally derived. At present silk imports into India more than balance exports.

Indo-China.—The large production of Indo-China is almost entirely for home consumption.

Persia, Georgia, Syria, and Asia Minor are considerable producers.

Italy.—By far the most important sericultural centre in Europe is the Lombardy Plain in Northern Italy. Not only is silk manufacturing carried on at Milan—the leading centre in Europe after, or even exceeding, Lyons in output—and at Como, Bergamo, etc., but there is also an export of raw silk to France only partly balanced by an import from Japan.

France.—The Rhône Valley is the centre of sericulture in France. Formerly the numerous mills of Lyons were supplied by local raw material, but now that supply is supplemented by imports from Japan and Italy.

Spain, Bulgaria, Yugoslavia, and Switzerland produce small quantities of raw silk.

World Trade in Raw Silk.—The trade in raw silk is relatively simple. Japan, Italy, and China supply four-fifths of the exports; the United States, France, Italy, and Switzerland are the leading importers.

ARTIFICIAL SILK

In recent years artificial silk, or rayon (the generic trade name), has been produced in greater quantity than true silk. All types are prepared from some form of cellulose, the usual raw materials being cotton waste or sawdust or wood pulp. The raw material is reduced to a cellulose jelly by chemical means and then forced through glass tubes of very small bore. The following is an estimate of production in 1923, 1925, 1930, 1936, 1937, and 1938 in millions of lbs.:

	1923	1925	1930	1936	1937	1938
U.S.A. .	35·4	51·0	112·0	278·0	321·0	257·9
Britain .	16·5	28·0	49·0	113·0	119·7	106·6
Germany .	13·0	25·0	48·0	112·0	143·3	132·0
Italy .	10·0	24·0	65·0	88·0	106·6	101·5
France .	7·7	14·0	40·0	42·5	72·8	75·0
Belgium .	6·0	10·0	10·0	13·5	17·2	15·5
Japan .	—	—	34·0	285·0	334·0	208·9
World . .	97·0	173·5	410·0	1,020·0	1,218·9	988·8

FLAX

The flax plant (*Linum usitatissimum*) is a slender plant about 2 feet high with one main stem, slender leaves, and pretty blue flowers. It is grown either for fibre or for seed (linseed).

Conditions for the Growth of Flax.—Flax grown for seed is mainly a tropical plant (*e.g.* it is important in India). The fibres are coarse and only fit for rope. When grown for fibre it is essentially a temperate plant. It requires a well-drained, clean, heavy soil. The seeds are planted very closely, since the closer together the plants can be made to grow the finer the stems and the better the fibre. The crop requires constant attention, several ploughings, hand weeding, etc. It is very exhausting to the soil and is usually grown in a seven-year rotation with other crops. Soil and labour are more important than climate.

Preparation of Commercial Flax.—The harvesting consists of pulling up the plant by the roots just before the seeds ripen. The first process of rippling consists of passing the stems through a comb with long teeth to get rid of any seeds. The useful fibres are arranged as bundles round the central woody core. The process of retting, performed by standing the flax upright in soft water for two weeks, or sometimes by the action of dew or, in the United States, by steam, rots the soft tissues and allows the separation of the fibres from the woody core. The latter is broken by the whole being passed through heavy rollers (breaking), and the fragments are then beaten out (scutching), leaving the flax fibres ready to be combed (heckling). The fibres are very long, fine, and supple. They are made up into 14-lb. bales for market. The yield of flax varies in an extraordinary way from about 80 lbs. per acre (Sweden) to over 1380 lbs. (Belgium).

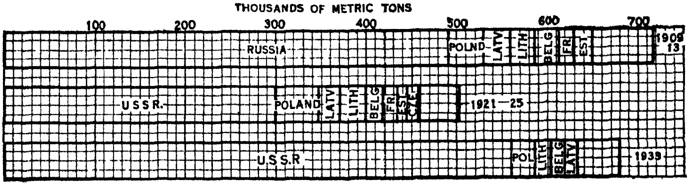

FIG. 151.—Production of flax in the principal countries.

In 1909–13 it should be remembered that Latvia, Lithuania, Esthonia, and a large part of Poland, though shown separated in the diagram, formed part of Russia.

Flax is the third most important textile material, and probably the oldest of all. It is still best where strength and durability are required—indeed, "fine linen," once a courtly garb, has become almost symbolical of purity and excellence.

World Production of Flax.—The great flax-growing region of the world is the North European Plain from Northern France and Belgium through Germany to the Baltic States and Russia. These are nearly all countries much affected by the war, hence the big drop in the world production. Flax has disappeared from among the crops of Great Britain, and occupies a dwindling acreage in Ireland. Italy has an important area under flax in the Plain of Lombardy. There is a small production in Japan and Canada.

JUTE

Jute is the cheapest of the fibres and is often referred to as the "brown paper of the wholesale trade." The fibre is weaker and less durable than flax or hemp, and is somewhat easily rotted by water. It does not bleach, but is easily dyed.

The jute plant (*Corchorus capsularis*) is raised from seed, and grows to a height of 10 or 14 feet. It grows best in well-drained soil; in muddy swamps the plants are taller, but the fibre is coarser. In the Ganges Delta, which yields over 9/10ths of the world's jute, the seeds are sown in March or April; in August or September the plant is ready for cutting. As with flax, the primary process is retting (in stagnant water), after which the fibre is stripped from the stem by hand, washed and dried in the shade before being sorted, graded, and baled. The yield is about 11 cwts. of fibre per acre.

Originally the preparation of jute was a peasant industry in Bengal and the fibre was used for making clothes. Its "discovery" as a substitute for hemp dates from 1832, and was made by a Dundee merchant. The jute trade developed along with the international trade in grain, since one of the principal uses of the fibre is in making sacks for grain. About half of India's jute is now manufactured into "gunny cloth" locally in mill towns north of Calcutta; the other half is exported to Great Britain—where hessian canvas and other jute fabrics are made at Dundee and Barnsley—to the United States and many other parts of the world.

World production averages nearly 1½ million metric tons, valued in the principal market (London) at about £30 per ton (1927 prices).

HEMP

Hemp is a general name given to a variety of fibres.

(1) True Hemp is a soft-fibred plant native to Central Asia and extensively cultivated in Russia, Italy, Yugoslavia, Poland, Korea, and elsewhere to the extent of over half a million tons a year. It is specially important in rope making.

(2) Manila Hemp is hard-fibred and produced almost entirely in the Philippine Islands, from the capital of which (Manila) it takes its name.

(3) Sisal Hemp, a hard fibre, from the leaves of a kind of aloe, is produced in Mexico, Tanganyika, and Kenya.

(4) New Zealand Hemp or Flax, from the sword-like leaves of *Phormium tenax*, can be used for textiles. There have been heavy drops in prices and quantities lately.

OTHER FIBRES

Ramie Grass or China Grass, used in making "grass linen," is one of the strongest known fibres; but the difficulty of removing the gummy substance from the ribbon is very considerable. The plant is widely grown in China.

Kapok, from the cotton tree, is an elastic and waterproof fibre, but is too short and brittle for weaving. The latter property prevents it from being baled.

Coir has been mentioned in connection with coconuts.

Raffia or Bass is obtained from the leaves of the *Raphia* Palm of Madagascar.

EXERCISES

1. Read current reports on world production and sales of raw cotton, and note any changes necessary in the account given under cotton.

2. Bring up to date Figs. 133, 134, and 139 (figures from the *Year Book of the International Agricultural Institute*).

3. Express in bales of 500 lbs. the cotton figures given in this chapter in metric tons.

4. Bring up to date Figs. 140, 141, 142, and 147 (*Year Book of International Agricultural Institute* and *Statesman's Year Book*).

5. Bring up to date Figs. 148 and 149. Ascertain whether any changes occur in Japanese sericulture and in China's exports.

6. Bring up to date Fig. 151 (*Year Book of the International Agricultural Institute*). Trace also production of linseed.

7. Watch for changes in India's output of jute and the direction of the trade in jute.

EXAMINATION QUESTIONS

1. What factors influence the supply of the world's silk, flax, jute, hemp, and sisal ? (*Univ. Toronto, Sessional,* 1926.)

2. Describe the general features of the manufacturing processes for flax, jute, and hemp, and contrast your description with the manufacture of cotton and wool. (*Univ. Toronto, Sessional,* 1926.)

3. Describe the factors determining the world's supply of cotton. (*Univ. Toronto, 1st Year Pass,* 1924.)

4. What are the chief conditions favourable to the cultivation of (*a*) cacao, (*b*) the coco-nut, (*c*) flax for fibre, (*d*) flax as a source of oil ? Mention *one* of the chief regions of production in each case. (*Univ. Bristol Inter.,* 1925.)

5. Write a general description of tendencies in production of the world's clothing supply.

How far are your conclusions affected by your description of the general tendencies in the production of the world's food supply ?

How far does the production of food and clothing supplies affect the world's timber supply ? (*Univ. Toronto, Sessional,* 1926.)

6. Write notes on the climatic and the edaphic (*i.e.* soil) conditions necessary for the large-scale production of any *four* of the following : oats, tea, sugar-cane, jute, citrus fruits, and cinchona. (*Univ. London Inter. B. Com.,* 1927.)

7. Give a general geographical account of the cotton lands of the U.S.A. (*Univ. London Inter. B. Com.,* 1927.)

8. What geographical conditions are necessary for sheep farming ? Illustrate your answer by special reference to South Africa and Canada. (*Univ. London Inter. B. Com.,* 1927.)

Explain carefully how it is that a statement of the average annual temperature and rainfall of a locality is not sufficient evidence that its climate is suitable to the production of a particular crop. And discuss specially what climatic conditions limit the cotton production areas of the U.S.A. (*Univ. London Inter. B. Com.,* 1922.)

10. What parts of the British Empire seem to you suitable for a further extension of cotton-growing? State what you regard as the favourable factors in each area which you name (*Univ. London Inter. B. Com*, 1923.)

11. State the chief conditions, physical and economic, which fit an area for large-scale cotton production. Illustrate by examples. (*Univ. London Inter B.Sc. (Econ*), 1924.)

12. Give a geographical account of the wool production of the Australian Commonwealth (*Univ. London Inter B Com.*, 1921.)

13 Indicate the chief regions, in Europe, of the commercial production of any three of the following: (*a*) citrus fruit; (*b*) fibre flax; (*c*) raw silk; (*d*) rice. In each case add notes commenting on the climatic characteristics of the areas you name. (*Univ. London Inter. B. Com.*, 1925.)

14. Analyse the geographical factors in the production of raw cotton in India. (*Univ. London Inter. B.Sc. (Econ.)*, 1930.)

15. Describe carefully the geographical conditions necessary for the production of cotton and show how these requirements are satisfied in the chief areas of production in North America and Asia. (*Univ. London Inter. B. Com.*, 1930.)

16. Write notes on the conditions of soil and climate favourable to the production of flax and jute.

17. What geographical conditions are necessary for large-scale sheep farming? Illustrate from the Southern Hemisphere. (*Univ. London Inter. B. Com.*, 1932.)

18. Give an account of the geographical conditions necessary for the large-scale production of (*a*) maize, (*b*) mutton. (*Univ. London Higher Schools E*, 1932.)

19. On an outline map of the world provided, indicate the chief cotton-growing areas, the chief cotton-manufacturing regions, and the routes by which the raw cotton is sent for treatment. (*Univ. London Higher Schools B & D*, 1932.)

20. What geographical factors tend to limit the areas within which sheep-rearing can be profitably carried on? Illustrate your answer from one of the three southern continents and deal with the special difficulties arising in the area chosen. (*Univ. London Inter. B.Sc. (Econ.)*, 1932.)

21. Examine the geographical bases for the development of textile industries in India *or* China *or* Japan. (*Univ. London Inter. B.Sc. (Econ.)*, 1934.)

CHAPTER X

OTHER RAW MATERIALS OF VEGETABLE ORIGIN

TIMBER

THE timbers of the world fall into two great groups—" soft " woods and " hard " woods.

Softwoods are derived from coniferous trees and come almost entirely from the cold temperate forests.

Hardwoods are obtained from broad-leaved trees, and may be again separated into temperate hardwoods and tropical hardwoods.

The common timbers for building and constructional work, as well as for pit props, wood pulp, boxwood, and cheaper furniture, are all softwoods. Even excluding wood for pulp over 80 per cent. of the world's timber requirements are for softwoods. Of the remaining 20 per cent. of hardwoods 18 per cent. come from temperate lands, 2 per cent. only from the great stretches of equatorial and tropical forests.

Softwoods.—The pines form the chief commercial timber—strong, light, durable, and easily worked. The firs are similar in character.

Fig. 53 shows that nearly all the great coniferous forests are situated in the Northern Hemisphere. The forests of Scandinavia (especially Sweden) and the Baltic States supply some of Britain's needs. By means of scientific forestry and afforestation—including the planting of enormous areas in the Landes—France maintains a supply of soft timber and even exports pit props. The mountain forests of Southern Germany and Central Europe are important sources of timber, and so are the forests of the Apennines and the Balkan Mountains; but in Europe as a whole consumption of softwoods exceeds growth by about 3,000 million cubic feet per year. (Consumption 9,000,000,000 cubic feet.)

The largest reserves are in Northern Russia and in the great stretch across Siberia. These vast forests cannot, however, be economically exploited owing to their inaccessibility. Much of the timber, especially in the marshy tracts of Siberia, is believed to be of little use. Out of an area of 1,300,000,000 acres only 75,000,000 can be classed as effective. The once enormous timber reserves of Canada and the United States are being used up at a very rapid rate. About three-quarters of Canada's merchantable timber has already been utilized or destroyed by fire. In Eastern Canada the lumbering industry centres on Ottawa, but the extraction of large timber has now given place to the utilization of smaller trees for the wood-pulp industry. British Columbia has become the chief lumbering state. Here are found the famous giant Douglas firs and cedars.

In the United States there are four main areas :

(1) New England, in which the original forests have now been almost entirely cleared, the timber mills depend largely on Canadian supplies.

(2) The Lake States. Only about 20,000,000 acres are now said to be left out of an original stand of 112,000,000 acres.

(3) The Gulf States. This is the source of the beautiful pitchpine. The forests occur especially along the coastal strip, but only about 31,000,000 acres remain out of about 250,000,000.

(4) The Pacific States, especially Washington. These states have now the largest reserves, and are the principal lumbering centres.

In the Southern Hemisphere New Zealand yields small quantities of the well-known kauri and rimu pines; small plantations of pines have now been made in Australia and, to a greater extent, in South Africa.

Speaking generally, a serious shortage of softwood seems likely in the near future.

Temperate Hardwoods.—Of these the oaks are the most important, and come from regions with a Cool Temperate Oceanic Climate (North-Western Europe), a St. Lawrence type (North America), and to a less extent from the Mediterranean. The majority of furniture and "luxury" woods are hardwood. Many of the eucalypts of Australia yield excellent timber, and the trees are quick growing. The jarrah and karri of Western Australia are specially important.

Tropical Hardwoods.—Of these the well-known standard, teak, comes almost entirely from Burma and Siam, the mahoganies mainly from Central America and West Africa. There are vast reserves of beautiful hard timbers in the great equatorial forests, but they are usually very hard and far more difficult to work than temperate hardwoods. The heavy Burma Ironwood or Pyingado, for instance, is not only very hard, but is so heavy that it sinks in water.

The great need at the present time is extensive afforestation in temperate lands.

NOTE.—The above section on timber has been based partly on a paper by Professor Fraser Story, on the World's Timber Supply and Consumption, read before the British Association, 1927.

WOOD PULP AND THE WORLD'S PAPER INDUSTRY

Paper is made from a variety of vegetable fibres reduced under water to a fine pulp, the pulp being bleached white by chloride of lime. Nearly all paper is now machine made, the pulp is fed on to a revolving endless band or apron of gauze, then on to a felt apron, and then through the pressing rollers. Formerly rags afforded the readiest raw material; now over nine-tenths of the total paper used is made from wood pulp. Wood pulp is made in two ways, mechanically by grinding the wood, and chemically by digesting the wood with an acid solution of calcium and magnesium bisulphite or with caustic soda. Mechanical pulp is used for newsprint and wrapping papers, and chemical pulp, which is more expensive to produce, but which ensures durability in the paper, for better quality papers.

Four conditions must be satisfied for the large-scale production of pulp. First, a large and continuous supply of softwood timber, *i.e.* wood of the Cold Temperate Coniferous Forests. Spruce is the principal timber used, together with various species of fir and pine. Secondly, cheap power, since energy to the extent of roughly 100 h.p. is necessary for the production of one ton of paper per day. Thirdly, an abundant supply of water; and fourthly, cheap and efficient transport both for the supply of raw materials and chemicals and for the distribution of the pulp or paper. On a large scale, the necessary conditions only exist in the United States, Canada, Sweden, Norway, Finland, and the mountainous parts of Germany. The countries are given in order of their production of wood pulp.

The United States has the largest consumption per head, and not only consumes the whole home production, but takes four-fifths of Canada's output. The European countries mentioned can roughly supply the needs of Europe as a whole. Japan can barely supply her own needs of cheap paper, but exports certain superior qualities. Australia, the whole of Africa, and the greater part of South America are virtually dependent on foreign supplies. Siberia has vast untouched forests, but the necessary power and transport facilities are at present lacking.

Canada's annual consumption of wood for pulping is 400,000,000 cubic feet, but it is estimated (1927) that, in addition to a reserve of 100,000,000,000 (a hundred billion) cubic feet of lumber timber, she has another hundred billion suitable for pulping. The industry is centred at present along the southern fringe of the coniferous forest tract in Eastern Canada. The innumerable lakes and rivers of the Canadian Shield afford the water which is so necessary, and the region is conveniently near the great industrial districts of the United States.

Although the majority of cheap papers are at present manufactured from wood pulp, paper can be made from a great variety of vegetable materials. Among these may be mentioned cereal straws, bamboo, and various grasses. The great grain-producing countries of the world are likely to turn their attention to straw as a raw material, but the supplies available are unlikely to be much more than sufficient for local requirements.

The world trade in the better types of paper is to some extent independent of that in the poorer types. In America the fine surfaced magazine papers are made largely from the softer of the "hardwood" trees—such as poplar—which grow, especially, with the St. Lawrence type of climate. Esparto grass still retains an important place as a raw material for better quality paper. Esparto grass is produced in considerable quantities in North Africa and Spain. There is, indeed, no lack of raw material for the finer types of paper. Linen and other rags are still used in considerable quantities. Some countries specialize in the manufacture of finer types of paper. Great Britain, for example, imports pulp and newsprint paper, but exports good quality paper. The same is true of Japan and China, which have long been famous for special types.

RUBBER

Rubber is the coagulated juice of a number of equatorial trees and woody climbers. One of the latter, *Ficus elastica*, may perhaps lay claim to being the original "India" rubber, but nearly all the rubber of commerce is now obtained from the Para rubber tree, *Hevea braziliensis*. A native of the equatorial forests of the Amazon, after great difficulties the tree was introduced into Ceylon, Malaya, and India. The introduction was carried out *viâ* London, where seeds from South America were germinated in 1876 and the young plants sent to Ceylon. The real usefulness of rubber dates from the discovery of vulcanization, whereby the mixing of a small quantity of sulphur with the rubber at high temperatures destroys the stickiness of pure rubber and makes it able to withstand great extremes of heat and cold.

Conditions Necessary for the Cultivation of the Rubber Tree.—In its natural habitat in the equatorial forests of Brazil, the rubber trees occur widely scattered amongst a great variety of other trees. The same is true of the rubber-yielding trees of the equatorial forests of the Congo Basin. When located it was usual to cut down the tree and collect as much latex or juice from it as possible. Trees soon became more difficult to find and very inaccessible when found. As a result, the annual output of "wild" rubber is now very small. Rubber plantations require a climate of an equatorial type, or one closely approaching it. A long dry season is harmful, though a short dry season (as in Lower Burma) or two (as in Ceylon) allow the tree a resting period and may be beneficial. Heavy rainfall is required—generally between 50 and 200 inches. A rich, well-drained soil is essential, and to secure adequate drainage the plantations are often made on hill slopes. On level ground the plantations are well provided with dikes or drains. Rubber plantations require careful weeding and the ground is usually kept entirely bare of vegetation.

Production of Commercial Rubber.—The milky latex from which rubber is made is contained in the bark of the tree. An oblique slit, or series of slits, is made by a sharp knife halfway round the tree and the latex runs down into a little earthenware cup provided for the purpose. Practice varies, but from the seventh year, when the trees come into bearing, a fresh cut is made usually daily or every other day in the early morning and the latex collected an hour or so later. In some plantations the tree is allowed a resting period during the year. Great skill is required in cutting not to injure the lower living layers of the trunk. After straining, a small quantity of acetic acid is added to the latex. After about twelve hours it has curdled and become white. It is then passed between rollers to squeeze out the water. The strips are then dried and form crêpe rubber, pale yellow in colour, or dried with smoke, forming smoked sheet rubber, dark in colour. It is exported in these forms.

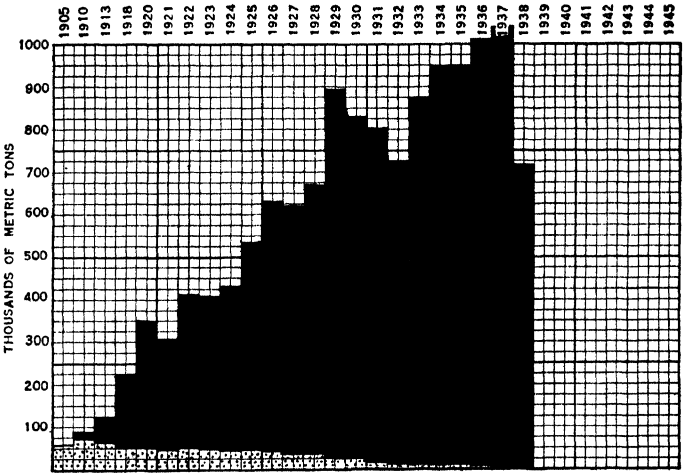

FIG. 152.—World production of rubber.
Plantation rubber in black; wild rubber dotted.

World Production of Rubber.—Fig. 152 shows the amazingly rapid increase in world production of rubber. Despite the huge increase in consumption for motor tyres, rubber sheeting, and for innumerable other uses, consumption has scarcely kept pace with production. The consequent fall in prices threatened to ruin the majority of rubber planters with the result that British rubber-growing countries (Ceylon, India, and Malaya) adopted the Stevenson Restriction Scheme. Producers agree to restrict their output to a definite percentage of their full capacity, the percentage fluctuating according to demand and resulting price levels. The British rubber-planting industry was temporarily saved by the scheme, but producers of other nationals, especially the Dutch East Indies, in the meantime increased their output. After the removal of restriction in 1929, the price of rubber fell to the very low figure of 2¾*d.* per lb. (August, 1931) consequent upon over-production.

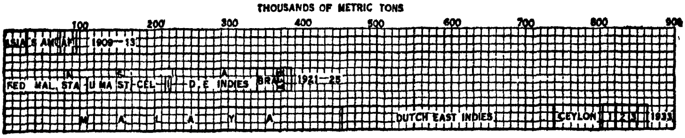

FIG. 153.—Production of rubber in the principal producing countries.

U. Ma. St. = Unfederated Malay States and Straits Settlements. Malaya comprises this in addition to the F.M.S. 1 = British Borneo; 2 = Indo-China; 3 = Brazil.

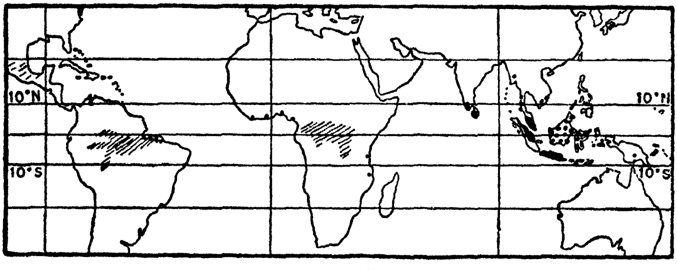

FIG. 154.—Map showing the rubber growing countries.

Solid black and dots indicate plantation rubber; lined areas wild rubber. Each producing area should be carefully identified.

The Principal Rubber-growing Countries of the World.—Fig. 153 shows the relative output of the chief countries. It emphasizes the small place now occupied by the "wild" rubber of Brazil (Amazon Basin) and the Belgian Congo (Congo Basin), which once supplied the whole of the world's requirements. The controlling position occupied by Ceylon, India, and Malaya has already been markedly affected by increased production in the Dutch East Indies, and will be still more affected when the plantations of West Africa (Nigeria, etc.) and the Amazon Basin itself become more important.

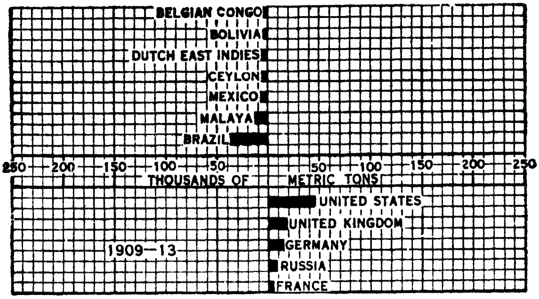

Fig. 155.—World trade in rubber, 1909–13.

The production of the Malay Peninsula (Malaya) has been treated as a whole; the rather complicated relationship between the Federated Malay States, the Unfederated States, and the Straits Settlements will be mentioned in Part II.

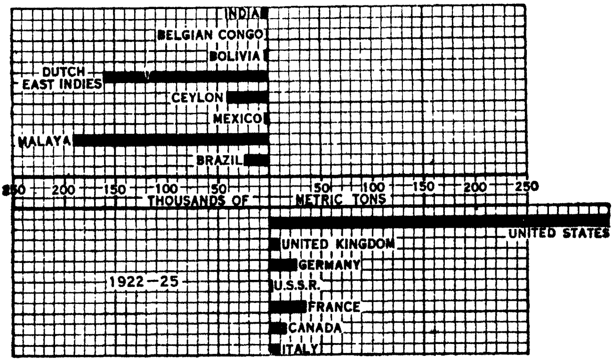

Fig. 156.—World trade in rubber, 1922–25 (approximate figures only).
The year 1921 has been omitted from the average because of the very big slump of that year.

World Trade in Rubber.—The total quantity of rubber entering into the channels of international trade exceeded 1,200,000 tons in 1929. Nearly all the rubber produced enters into trade—very little is used in the equatorial countries of its origin. The outstanding feature of the trade is the huge consumption of the

United States and the fact that the United States is dependent on foreign supplies almost entirely. Therein lay the grievance of the United States against the Stevenson Restriction Scheme which, though it may have saved from ruin the British planters, naturally kept up prices. The diagram explains the remainder of the trade.

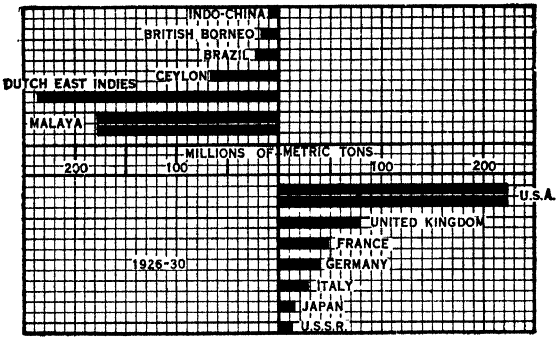

FIG. 157.—World trade in rubber, 1926–30.

EXERCISES

1. Draw a map of the world to show the principal areas producing softwoods.

2. Draw another map of the world to show (*a*) producing areas of hardwoods, (*b*) potential hardwood areas.

3. Draw diagrams to show the export trade in lumber of the principal producing countries (figures from *Commerce Year Book* or *Statesman's Year Book*).

4. Bring up to date Figs. 152, 154, and 157 from the *Year Book of the International Agricultural Institute*, or from the *Statesman's Year Book*.

EXAMINATION QUESTIONS

1. State the climatic and other geographical conditions required for the production of "plantation rubber," and compare the relative importance of the chief producing areas. (*Univ. Bristol Inter.*, 1926.)

2. Where is the bulk of the world's supply of crude rubber produced at the present time?
What advantages have the rubber plantations of these regions over the areas which yield "wild" rubber? (*Prov. Alberta, 3rd Year Matric.*, 1926.)

3. From what parts of the world, and under what conditions, have supplies of (*a*) rubber, and (*b*) the chief vegetable oils hitherto been obtained? Add a note on possible future developments. (*Univ. Bristol Inter.*, 1924.)

4. In what regions in Canada is the manufacture of pulp and paper an important industry ?

Account for the rapid development of this industry in these regions. (*Prov. Alberta, 3rd Year Matric.*, 1926.)

5. Describe the process of the manufacture of paper from sulphate pulp. What are your predictions as to the future of this industry in Canada ? (*Univ. Toronto, 1st Year Hons.*, 1926.)

6. Write an essay on the "forest industries" of Eastern Canada. (*Univ. London B.A. Hons. Econ. Geog.*, 1927.)

7. What are the geographical factors which control the world's paper industry ? (*Univ. London Inter. B. Com.*, 1927.)

8. Describe the world distribution of, and world trade in, rubber. What future developments are probable or possible ? (*Univ. London Inter. B. Com.*, 1927.)

9. What do you know of the wood pulp and paper industry of Canada ? (*Asst. Insp. Taxes, G.B.*, 1927.)

10. What parts of Europe, in normal times, export considerable quantities of (1) flax fibre, (2) lumber, (3) wheat, and why ? (*Univ London Inter. B. Com.*, 1924.)

11. Discuss the value of tropical timber, with special reference to specific areas. (*Univ. London Inter. B. Com.*, 1923.)

12. Discuss the distribution, and the nature of the utilisation, of commercially useful timber in Canada and the United States. (*Univ. London Inter. B. Com.*, 1930.)

13. Give an explanatory account of the world distribution of useful timber. (*Univ. London Inter. B. Com.*, 1928.)

14. What are the main sources of raw material for paper-making ? Explain the relative importance of the chief areas of production. (*Univ London Inter. Arts*, 1930.)

15. What geographical conditions favour the large-scale production of (*a*) raw silk, and (*b*) rubber ? Mention the main areas of production and the markets they supply. (*Univ. London Inter. B.Sc. (Econ.)*, 1932.)

16. Write a geographical account of the timber and pulpwood resources and industry of *either* Canada *or* north-eastern Europe. (*Univ. London Inter. B.Sc. (Econ.)*, 1932.)

17. What possibilities do you consider exist for the economic development of the northern coniferous forests ? Distinguish carefully between the various areas concerned. (*Univ. London Higher Schools E*, 1932.)

18. Examine critically the view that the British Empire can be self-supporting in its requirements of (*a*) timber, and (*b*) cotton. (*Univ. London Inter. B. Com.*, 1932.)

CHAPTER XI

POWER

At the present time there are three fundamental sources of power—coal, oil, and moving water. In the future it may be necessary to include alcohol or other industrial fuels, whilst the utilization of solar energy may add another and extremely important source of power. The force of the wind is, curiously, less utilized than formerly. We sometimes refer to electricity, gas, or petrol as if they were the actual sources of power, forgetting that electricity must be generated by the consumption of coal or oil or by the utilization of water-power, and that gas and petrol really represent but methods of utilizing, to the fullest extent, coal or oil. We shall therefore consider in this chapter the distribution and utilization of the three great fuels—coal, oil, and " white coal."

In the first place, between coal and oil on the one hand and water-power on the other there is a marked contrast. Unlike the commodities of animal and vegetable origin which, generally speaking, are renewed year by year by natural means, the stores of coal and oil in the earth's crust—in common with nearly all mineral substances—are not replenished as they are utilized. They are won by man on the principle of " robber economy." Supplies of water for the generation of water-power, on the other hand, are replenished from year to year. In the long run the most fortunate countries may be those well supplied with sources of water-power rather even than with coal or oil.

Centralization and Decentralization. — The industrialism characteristic of a large number of coalfields is a theme so commonly stressed in geographical text-books that it will be accorded but a passing mention here. The bulk and weight of the coal required in the majority of manufacturing industries is large in comparison with the bulk and weight of the raw material. This is true, for example, of the textile industries. It is obviously cheaper to take the raw material to the fuel than the fuel to the raw material. This has resulted in the concentration of manufacturing industries on the great coalfields—a concentration which is particularly well marked in Great Britain.

The modern tendency is towards decentralization rather than an accentuation of the centralization on the coalfields. This modern development is closely connected with the growth in the use of oil fuel and of electricity. Oil fuel can be pumped long distances so that the great oilfields have not become industrial centres. Electricity can be generated from coal on the coalfields, or where water-power is available and transmitted to points where required for factories—very often to the region of origin of the raw material. At the present time transmission of electricity up to 300 miles is common. In the new countries, where coalfields have only been developed within the last half century, industrialization of the coalfield regions is thus less marked.

COAL

Formation of Coal.—Seams of coal represent the remains of vegetation of past ages. Underlying the coal seam there is usually a bed of clay in which the remains of roots and rootlets may be detected and which was originally the muddy floor of the swamp in which the coal forest grew. We can picture the typical coal forest as a huge, level swamp with a muddy floor covered by two or three feet of water. Successive generations of plants—very different from anything existing in the world to-day—sprang up, grew and died and added their quota to the mass of decaying vegetation in the stagnant water. The process of accumulation was only terminated by some catastrophic event, most probably an earthquake, which diverted the waters of some great river so that it overwhelmed the forest and buried its vegetation under great masses of sand and clay. The nearest approach we find to the conditions is in such areas as the flooded portions of the Amazon Forests, some of the great stretches of mangrove swamp, or such famous areas as the Dismal Swamp of Virginia. There have been certain times during the earth's history when suitable conditions were extraordinarily widespread over its surface. The most notable of all such periods is that known to geologists as the Carboniferous. The great coal-bearing rocks of Europe—including the British Isles—and Eastern North America were laid down in this period. The coal seams of India and the Southern Hemisphere (South Africa and Australia) were formed partly in this and partly in the succeeding Permian Period, and are referred to as being of Permo-Carboniferous age. These two systems contain the great bulk of the world's coal. The succeeding Mesozoic deposits (including the Triassic, Jurassic, and Cretaceous Periods) contain important coal reserves in Western North America and Central Asia. In the later Tertiary deposits, brown coals and lignites are more usual, though true coals do occur. The important fields of Japan, North-Eastern Siberia, and New Zealand are of this age; there are important fields in Central and Southern Europe, on the Great Plains and the Pacific slope of North America and in the western and northern parts of South America.

From what has been said, it will be clear that coal is only found in regions of sedimentary rocks (see Chapter II) and never in association with igneous or metamorphic rocks, or with sediments laid down under deep-sea conditions. Originally the coal seams must have been horizontal; in some areas they remain approximately so at the present day. But in most areas the coal measures lie in regions which have been considerably affected by earth movements: in common with the surrounding rocks the coal seams have been folded and faulted; in some cases the coal considerably crushed and even powdered; and in many cases brought within the sphere of action of the agents of denudation so that only fragments of the original seams remain. In a large number of areas the coal seams lie buried at such depths that it is at present impracticable to work them.

The Coal Resources of the World.—The Twelfth International Geological Congress which met in Canada in 1913 made a special study of the Coal Resources of the World and, although in certain areas a large amount of detailed knowledge has since been gathered, the three-volume monograph published then remains as the most convenient summary of the world's resources. The Congress laid down two main classes of reserves:

> (1) Coal of economic value contained in seams of workable thickness situated within a mineable distance of the surface. This group includes seams of 1 foot or over, to a depth of 4,000 feet.
>
> (2) Coal of economic value contained in seams of workable thickness, situated beyond present mineable distance of the surface, but possibly of future availability. This group includes seams of 2 feet and over at depths between 4,000 and 6,000 feet.

In each group reserves were grouped as Actual, Probable, and Possible; of the Actual and Probable estimates could be given.

The Congress distinguished four main types of coal, which they labelled Class A, Class B, Class C, and Class D. These correspond roughly, however, with the common division into Anthracite, Humic or Bituminous Coal, Cannel Coal, and Brown Coals or Lignites.

Anthracite is a very hard, bright coal which does not readily ignite, since it contains only a small proportion of volatile matter, and which does not coke.

Humic or *Bituminous Coal* includes the ordinary House and Steam Coals. Those coals which readily coke are termed " Coking Coals " ; those which are most suitable for raising steam are known as " Steam Coals," though the exact range included in such general terms is usually difficult to define.

Cannel Coal, which burns with a long smoky flame like that of a candle, and which breaks with a resinous fracture, forms a small and curious class.

Brown Coal or *Lignite* usually contains a considerable proportion of moisture, and after mining frequently breaks up into small pieces owing to the drying out of the moisture. In many lignites the original fragments of wood, rootlets, or leaves may still be distinguished. Most of the younger coals belong to this group.

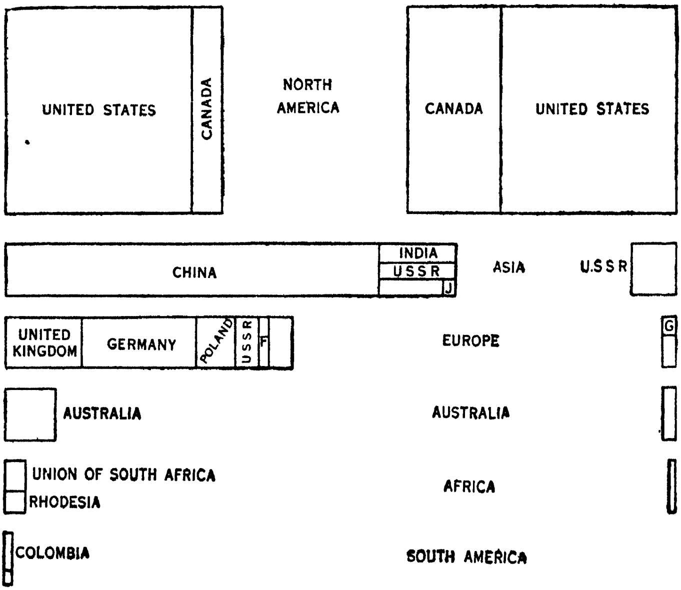

FIG. 158.—Coal resources of the world, from the tables compiled by the International Geological Congress, 1913.

Areas on the left show reserves of bituminous coal; on the right, brown coals and lignites.

Fig. 158 has been drawn to show the estimated coal resources of the world. The most doubtful estimate is that of China. More recent and more conservative estimates by the Chinese Geological Survey put the total at 200,000,000,000 metric tons instead of 996,000,000,000.

Coal Reserves of the World in Millions of Metric Tons

	Anthracite	Bituminous and Cannel coals	Brown coals	Totals
Australasia	*659*	*133,161*	*35,138*	*168,958*
Australia	659	132,250	32,663	165,572
New Zealand	—	911	2,475	3,386
Asia	*407,637*	*760,418*	*112,983*	*1,281,038*
China	387,464	607,523	600	995,587
Japan	62	7,130	778	7,970
India	—	76,399	2,602	79,001
Africa [1]	*11,662*	*45,123*	*1,054*	*57,839*
Union S.A.	11,660	44,540	—	56,200
North America	*21,842*	2,239,683	2,811,906	5,073,431
Canada	2,158	283,661	948,450	1,234,269
United States	19,684	1,955,521	1,863,452	3,838,657
South America	*700*	*31,397*	—	*32,097*
Europe	*54,346*	*693,162*	*36,682*	*784,190*
	496,846	3,902,944	2,997,763	7,397,553

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[1] Now known to be larger.

Exploitation and World Production.—Fig. 159 shows the world's total coal production in recent years. The graph should be kept up to date from the current number of *The Mineral Industry*. The figures given in the *Statesman's Year Book* are rather smaller as certain countries, whose exact production can only be estimated, are excluded.

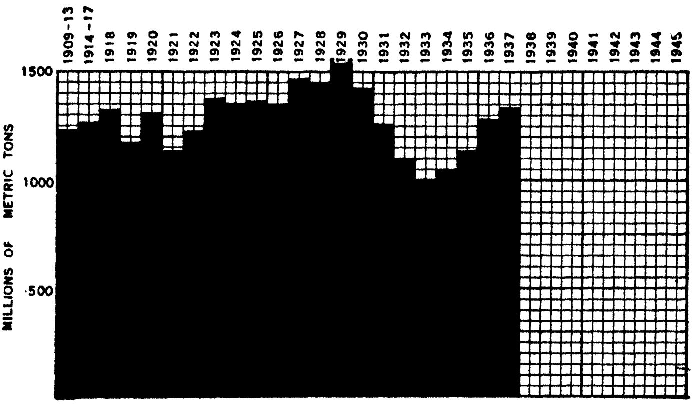

Fig. 159.—World production of coal, including lignite.

(From *The Mineral Industry;* figures given in the *Statesman's Year Book* are smaller, because lignite is excluded and the coals are in long tons of 2,240 lbs.)

Fig. 158 has shown us, at least roughly, the location of the great reserve resources of coal in the world. Fig. 160 shows the present production of the principal countries (from *The Mineral Industry* or the *Statesman's Year Book*). It will be seen at once that present production is not proportionate to reserves ; in other words, some countries (notably Great Britain) are using up their supplies at a rapid rate, whilst in others (notably China) the vast deposits are scarcely being touched.

The Principal Coalfields of the World.— THE UNITED STATES. —The United States now produces roughly 40 per cent. of the world's total output of coal, whilst the reserves are believed to be roughly equal to the remainder of the world put together.

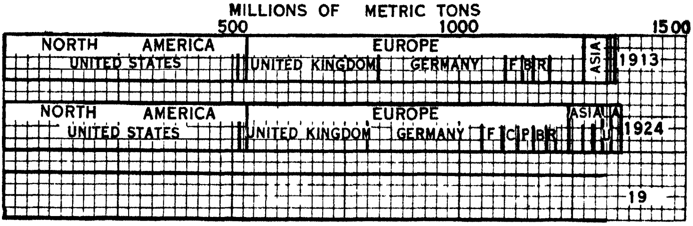

FIG. 160.—Production of coal (including lignite) in the principal countries.

This diagram serves mainly to emphasize the predominating importance of the three leading producers—United States, United Kingdom, and Germany. F=France; B=Belgium; R=Russia (pre-war frontiers in 1913 diagram); C=Czechoslovakia; P=Poland; U=Union of South Africa; A=Australasia. The proportions recently have remained substantially similar

Fig. 161 has been drawn to show in a generalized way the position of the principal fields. The distinction between the Carboniferous and the Post-Carboniferous coal areas should be carefully noted, since a very large proportion of the coal in the latter is lignitic in character. The principal worked coalfields may be grouped as follows :

(1) *The Pennsylvania Anthracite Field.*—This field lies in the eastern part of the State of Pennsylvania, and has the largest output of anthracite of any field in the world. In normal years the production is about 70,000,000 tons, valued at the mines at between $6 and $7 per ton (1933, 49,000,000 tons at $4–$5).

(2) *The Appalachian Fields.*—The enormous extent of these fields is at once apparent from the map. At present the centres of production fall into three main groups :

(*a*) The Northern Appalachian Fields, including the great Pennsylvania (Bituminous) Field around Pittsburgh ; the chief coal-producing area of Ohio, and the area lying in the northern part of West Virginia.

(*b*) The Middle Appalachian Fields, lying in Kentucky, West Virginia, and Virginia. This group includes the Grand Kanawha, New River, and Pocahontas Fields.

(*c*) The Southern Appalachian Fields, lying in Alabama and Tennessee and of which the area around Birmingham is the most important. There has been a very rapid extension in recent years in the development of the Southern Appalachian region.

The Appalachian Fields together yield roughly 70 per cent. of the United States' coal output.

(3) *The Eastern Interior Fields.*—These fields form a huge basin covering the greater part of Illinois and extending into Indiana and Western Kentucky. The main areas of production at present are along the western border in Illinois and along the eastern border in Indiana and Kentucky. Illinois occupies the third position, after Pennsylvania and West Virginia, as a producing state.

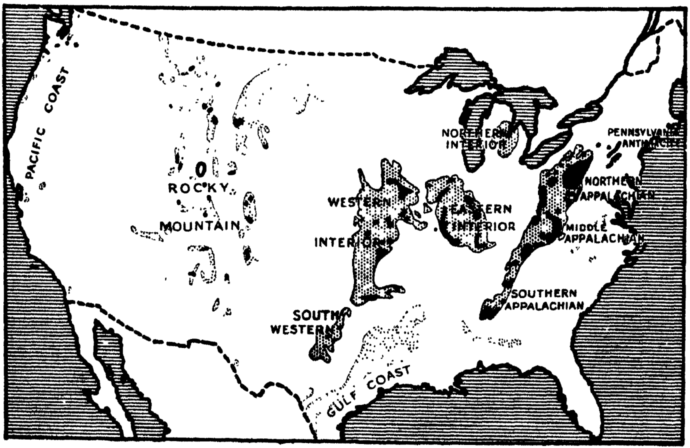
PACIFIC COAST
ROCKY MOUNTAIN
NORTHERN INTERIOR
PENNSYLVANIA ANTHRACITE
NORTHERN APPALACHIAN
WESTERN INTERIOR
EASTERN INTERIOR
MIDDLE APPALACHIAN
SOUTHERN APPALACHIAN
SOUTH WESTERN
GULF COAST

FIG. 161.—The coalfields of the United States.

(4) *The Western Interior Fields.*—These fields stretch from Iowa through Eastern Kansas and Western Missouri into Oklahoma and Arkansas.

(5) *The South-Western Fields.*—These comparatively undeveloped fields lie in Texas. The Oklahoma-Arkansas Fields are often grouped with the South-Western.

(6) *The Northern Interior Field.*—This field, lying in Michigan, has only a small output.

(7) *The Rocky Mountain Fields.*—As shown on the map there are numerous small fields of Post-Carboniferous age in the Rocky Mountain States from the Canadian to the Mexican border. The largest production is in Colorado and Wyoming.

(8) *The Pacific Coast Fields.*—These fields are also of Post-Carboniferous age, and largely undeveloped.

(9) *The Gulf Coast Fields.*—This is another undeveloped group of Post-Carboniferous age.

With the exception of the great iron and steel industries on the Pennsylvania Coalfield and the recent development of such centres as Birmingham, there is not a very marked tendency for the manufacturing industries of the United States to be concentrated on the coalfields. The industrial towns of New England and the Erie and Michigan lakeside regions are thus actually away from the coalfields.

CANADA.—The coalfields of Canada fall into three groups which show a close relationship with certain of the fields of the United States.

(1) *The Coalfields of Nova Scotia and New Brunswick.*—These fields are of Carboniferous age and are the chief stores of coal of that age in Canada.

(2) *The Rocky Mountains and Interior Plains Fields.*—Enormous areas of lignitic and sub-bituminous coal of Post-Carboniferous ages underly the prairies in Alberta (with reserves estimated at 1,000,000,000,000 metric tons). Small quantities of bituminous coal are worked in the Crowsnest Field on the eastern flanks of the Rockies.

(3) *The Pacific Coast Fields* include the deposits of Vancouver Island and the interior of British Columbia. Like the Pacific Coast Fields of the United States, the coals are of Post-Carboniferous age.

SOUTH AMERICA.—The coal resources of South America are still very imperfectly known. There is a small annual output—notably about a million and a half tons from the neighbourhood of Concepcion in Chile.

AFRICA.—The Union of South Africa has extensive deposits of good quality bituminous coal in Natal and underlying large areas of the Orange Free State and the Transvaal. There are two main centres of activity, one near Newcastle in Natal, whence the port of Durban is supplied with coal for bunkering and export; the other around Middelburg in the Transvaal which supplies the industrial district of Johannesburg and the Rand.

In Rhodesia there are numerous deposits: at present the one large colliery of Wankie supplies local needs.

In West Africa important deposits have been found in recent years in Nigeria and elsewhere.

AUSTRALIA.—There are several important coal basins both of bituminous and lignitic coals in the eastern states of Australia. By far the most important area is the great basin underlying Sydney. Coal is worked near the outcrop at Newcastle in the north, near

Lithgow in the west, and in the Illawarra district in the south. Another coalfield at present worked is at Ipswich in Queensland, whilst extensive lignite deposits at Morwell are being exploited to supply Melbourne with electricity.

In New Zealand the two chief fields at present exploited are around Westport and Greymouth on the west coast of the South Island.

ASIA.—*Japan* has several small but important fields, notably in the island of Kyushu near the port of Nagasaki and in the island of Hokkaido which supplies Hakodate. Although most of Japan's coal is Tertiary in age, it ranges in character from lignite to anthracite.

China.—Coal is widely distributed in China and some of the coal basins are very large. At present the output is insignificant in comparison with known reserves and practically restricted to a few localities near the few railways. Even so, much of the coal is produced by foreign capital, especially Japanese. The same is true of Manchuria.

Malaya, Indo-China, and the Dutch East Indies.—The coal deposits of South-Eastern Asia are mostly lignitic in character and Tertiary in age. They serve to supply local needs.

India.—Considerable areas of coal-bearing rocks of Permo-Carboniferous age exist in India. Nine-tenths of the present production come from the Jharia and Raniganj Fields on the borders of Bengal and Bihar and Orissa—about 120 miles west of Calcutta.

EUROPE.—Most of the independent political divisions of Europe include coalfields of variable size, but on the continent of Europe there are only half a dozen really important areas.

Great Britain.—The coalfields of Great Britain will be considered in greater detail in Part II. All the important fields are Carboniferous in age.

(*a*) The coalfields of Scotland lie in the Midland Valley, and include the fields of Lothian and Fife which supply the district round Edinburgh ; Lanark and Ayrshire, which supply Glasgow and the Clydeside iron, steel, shipbuilding, and textile industries.

(*b*) The coalfields of the North and Midlands of England were originally deposited right across the north of the country, but as a result of earth movements and denudation the seams now lie in a number of isolated basins grouped on the eastern and western sides of the Pennine Uplands. On the east lie the fields of Northumberland, Durham, Yorkshire, and Nottinghamshire ; on the west the coalfields of Lancashire, North and South Staffordshire.

(*c*) The Armorican Coalfields of England and Wales form a continuation of the great line of fields on the continent of Europe. By far the most important is the South Wales Coalfield, with the anthracite field in the west; smaller fields are those of Bristol and the recently developed East Kent Coalfield.

CONTINENTAL EUROPE.—(1) *The Coalfield of Northern France and Belgium.*—This long narrow field stretches from the shores of the Straits of Dover to the borders of Germany. It forms the leading coalfield of France, and has resulted in the great industrial area around Lille; it is to this field that Belgium owes much of her prosperity.

(2) *The Campine Coalfield of Northern Belgium and South-Eastern Holland* deserves mention because of its comparatively recent discovery and still partial exploration.

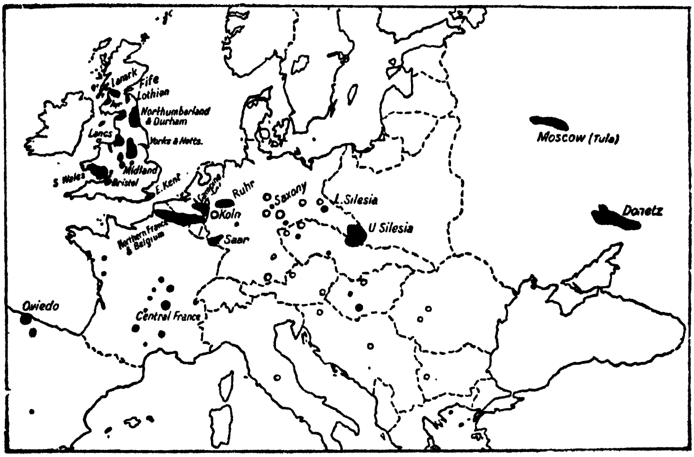
Lanark
Fife
Lothian
Ayr
Northumberland & Durham
Lancs
Yorks & Notts.
Midland
S Wales
Bristol
E. Kent
Campine
Ruhr
Koln
Saxony
L. Silesia
U Silesia
Saar
Northern France & Belgium
Central France
Oviedo
Moscow (Tula)
Donetz

FIG. 162.—The coalfields of Europe.

Solid black areas or dots show field of bituminous coal; circles indicate the principal lignite or brown coalfields.

(3) *The Ruhr Coalfield* is the great coalfield of modern Germany. Lying in the Ruhr Valley, a tributary of the Rhine, it has determined the position of the leading industrial area of Germany.

(4) *The Sarre or Saar Basin*, on the borders of France and Germany, is at present exploited by the former until the ultimate position of the field shall have been decided.

(5) *The Upper Silesian Coalfield*, formerly in the territory of the German Empire, has now been partitioned between Poland, Germany, and Czechoslovakia.

(6) *The Donetz Basin* is the principal field of Russia, and has reserves of anthracite as well as of bituminous coals.

(7) *The Coalfields of the Central Plateau of France* occupy a number of small basins lying amongst the ancient rocks of the Central Massif.

(8) *The Coalfields of Northern Spain,* notably round Oviedo, have considerable reserves.

All the above fields are of Carboniferous coals.

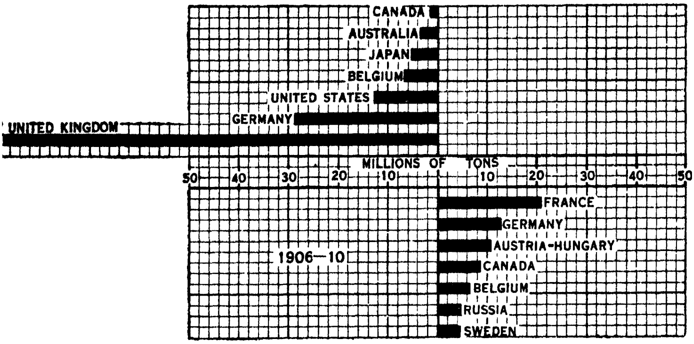

FIG. 163.—World trade in coal, 1906–10.
(Figures from Chisholm's *Handbook of Commercial Geography.*)

(9) *The Saxony Coalfields* are amongst the principal lignitic fields of Europe.

There are numerous other lignite fields in Central Europe.

EUROPEAN COALFIELDS
(In millions of metric tons)

Country	Reserves (1912-13 estimates)	Production		
		1922–24	1928–29	1933
Austria : lignite	720 [1]	2·9	3·4	3·2
Belgium	11,000	22·5	29·3	25·3
Bulgaria	388	1·1	1·5	1·5
Czechoslovakia : coal	28,400 [1]	12·7	16·5	10·6
lignite	12,000 [1]	18·7	22·5	15·1
France : coal	15,951	37·9	52·5	46·9
lignite	1,632	0·9	1·1	1·1
Germany (including Saar) : coal	350,000 [1]	115·1	170·0	110·5
lignite	13,381	126·6	170·1	126·8
Hungary : lignite, etc.	1,717	7·3	7·6	6·7
Italy : lignite	99	0·9	1·0	0·7
Yugoslavia : lignite, etc.	4,205 [1]	4·0	5·5	4·2
Netherlands : coal	4,402	5·5	11·6	12·6
Poland	80,000	30·9	43·4	27·3
Portugal	20	0·1	0·2	0·2
Rumania : lignite	39 [1]	2·4	2·6	0·6
U.S.S.R. (including Asiatic Russia)	60,106	13·2	36·7	76·7
Spain : coal	8,001	5·5	7·1	6·0
lignite	767	0·4	0·4	0·3
Spitzbergen	8,750	0·4	0·2	0·3
Sweden	114	0·4	0·4	0·3
United Kingdom	189,533	268·5	247·7	210·3

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[1] Approximate estimates, taking into consideration new frontiers.

Trade in Coal.—Of all the great industries affected by the war, that of coal mining has, perhaps, shown the least tendency to settle down into a stable course. Apart from the anomalous position occupied by the Saar Field and the delayed partition of the great Upper Silesian Field, any attempt to show the average post-war trade in coal would be upset by the troubled labour conditions which profoundly affected both production and export, and the conditions of the shipping trade which greatly affected the demand for bunker coal. Fig. 163 therefore shows the average international trade in 1906–10, Fig. 164 the trade in 1925. It must be borne in mind that the latter diagram is not necessarily typical.[1]

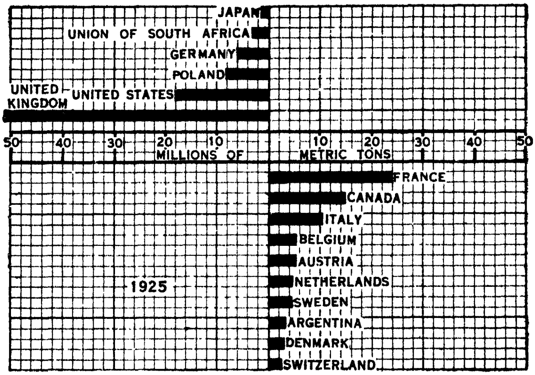

FIG. 164.—World trade in coal, 1925.

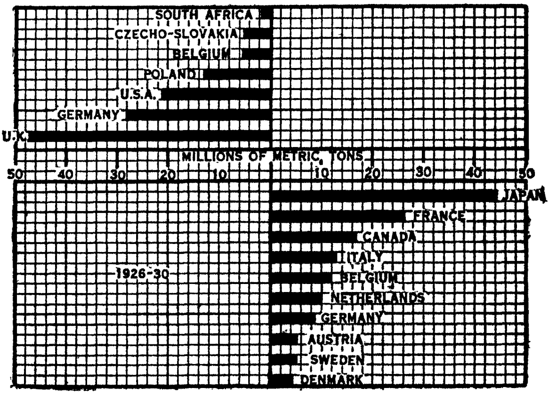

FIG. 165.—World trade in coal, 1926–30.

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[1] 1906–10 from Chisholm's *Handbook of Commercial Geography*; 1925 compiled from the *Reports on the Balance of Trade* (League of Nations).

An important point is that bunker coal—*i.e.* coal supplied as fuel for ships engaged in foreign trade—is not usually considered as coal exported. In 1922–25 Great Britain, in addition to exporting an average of 68,000,000 tons a year, supplied 17,600,000 tons of bunker coal annually. In 1929–33 the average figures were 48,800,000 and 14,900,000 respectively.

OIL

Conditions of Formation.—Mineral Oil or Petroleum is, like coal, found in sedimentary rocks. Its exact origin is still a disputed problem, but the majority of authorities tend towards the view that it is derived from vegetable matter deposited amongst sands under conditions which favoured the development of certain types of bacteria by whose agency the mother substance has been converted into oil. The conditions required seem to be those of shallow brackish water, such as is found on the seaward sides of great deltas or in certain lakes. The sediments with which large deposits of oil are associated are usually of the type deposited in great deltas—rapidly alternating beds of sand, silt, and clay. The rivers which brought down the masses of sediment must also have floated down the vegetable matter or other mother substance of the oil. For the accumulation of commercial quantities of oil, certain further conditions must be satisfied. Oil nearly always accumulates in lenticular bands of porous sand, along which the oil can flow, between beds of clay or shale through which it cannot pass. The oil-sands usually contain quantities of water, and in some cases the oil and water may form an intimate mixture or emulsion. The recovery of oil from an emulsion is extremely difficult. In order that an oil pool may be formed the strata must have been bent by earth movements into an anticline or arch. The oil, being lighter than water, rises towards the apex of the arch, being itself surmounted by a layer of gas. This arrangement is shown in Fig. 166. There are other types of structure in which oil pools may accumulate, but the anticlinal is the commonest. Fig. 166 shows also the area over which profitable oil-wells may be bored. It will be obvious that a large tract of country may be petroliferous, but the actual exploitable pools are strictly limited in area. Completely barren country (representing a syncline) may separate two rich oilfields situated on anticlines. There is often very little surface indication of the existence of an anticline below—hence the occasional success of " wild catting."

Exploitation.—There is a fundamental difference between the exploitation of coal and oil. Oil will flow; coal is a solid. An oil-well thus " taps " a variable, sometimes considerable, area round the actual bore. Many of the great oilfields have had an extraordinarily short life. Many of the American fields have reached their maximum output within two or three years of their discovery and then have rapidly declined. The exploitation of oil is relatively simpler than that of coal. Oil-wells are drilled by percussion—a heavy bit on the end of a wire rope is alternately raised and lowered and the loosened material washed out by a current of water. The well is lined with iron tubes—ranging in diameter from 2 or 3 to 17 or 20 inches. When the oil-sand is reached the oil may rush into the well and spout out at the surface as a " gusher." In other cases it must be pumped up. Some wells are drilled by rotary apparatus—a solid core being cut out and drawn to the surface. Wells of a less depth than 2,000 feet may be referred to as " shallow wells " ; the majority of "deep wells" are between 3,000 and 4,000 feet in depth, whilst wells have been drilled to depths of over 7,000 feet.

Crude oils, as obtained from the wells, vary greatly in composition. They may be divided roughly into two classes, those with a paraffin base and those with a petrol base. The treatment to which crude oil is subjected is determined very largely by its composition. Large quantities are used direct as fuel oils. But in cases where the crude is rich in the lighter constituents, it is obviously economic to split up the crude by fractional distillation to obtain the valuable petrol as well as kerosene or lighting oils and heavy lubricating oils and wax.

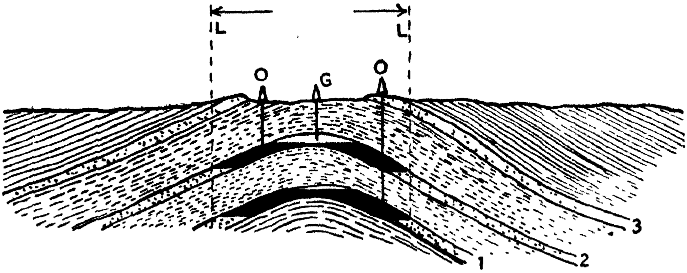

FIG. 166.—Section through an oilfield.

Oil sands numbered 1, 2, 3, but all oil from 3 has escaped (" seeped " away to the surface). Oil shown in black; O, O are oil wells; G is a gas well. L—L = limits of field.

The Oil Resources of the World.—It is impossible to gauge with any degree of accuracy the oil resources of the world. It must be emphasized that practically the whole world has been surveyed in outline by petroleum geologists, and practically all the possibly petroliferous regions are known. There remains, in certain countries, the task of locating further pools within those tracts. The majority of petroliferous beds belong to the Tertiary Period—in rocks of comparatively recent age, and in which the rocks have not become consolidated and hardened by the passage of time. Some of the important fields of the United States (Illinois, Pennsylvania, etc.) are, however, as old as Carboniferous.

It may be safely said that the world's petroleum will be exhausted long before many of the great coal reserves are even touched. At present, however, existing oilfields are capable of producing more than the world's requirements, hence restriction of output.

The World's Oil Production.—Fig. 167 shows the amazingly rapid increase in the world production of petroleum in the last quarter of a century. The decline in the rate of increase of the output in 1923 to 1926 was followed in 1927 to 1930 by huge annual increases. Restriction reduced the 1931 total to 1,360,000,000 barrels.

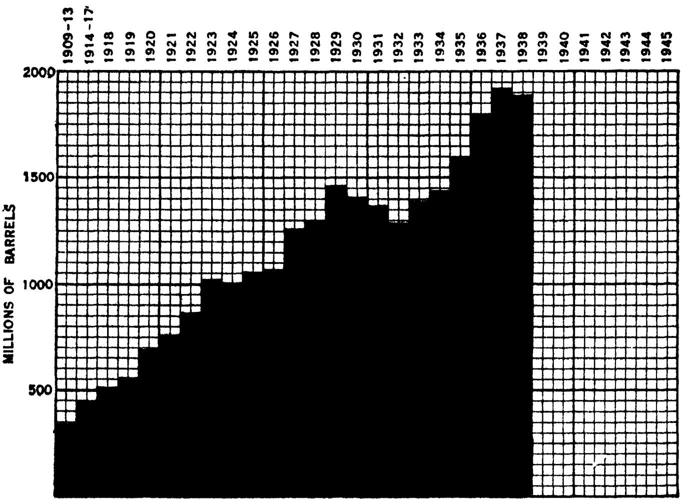

FIG. 167.—World production of oil, in millions of barrels of 42 U.S. gallons. Very roughly 7 barrels = 1 metric ton.

Fig. 168 shows the output of the leading producers, and illustrates the paramount importance of the United States. This diagram does not bring out one very important fact. The output of oil in the world is controlled, not necessarily by the nationals of the countries in which it is found, but by the great operating companies. Russia is to a considerable extent a special case, and so is Japan; the remainder of the world is divided between American interests on the one hand and British-Dutch interests on the other. A smaller part is played by French capital. Thus Persia is within the sphere of British interests; Mexico and South America are the battle-grounds of the rival groups. There is usually a considerable difference in the development policy of the leading companies.

Generally speaking, the British-Dutch groups aim at steady exploitation and conservation of supplies; the American fields, on the other hand, have been operated under a policy of much more rapid development with a consequent lowering of prices, and in some cases the evils attending over-production.

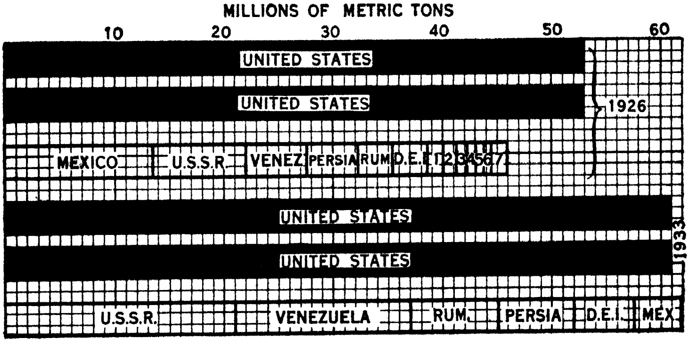

FIG. 168.—Production of oil in the principal producing countries.
Rum. = Rumania; D.E.I. = Dutch East Indies. 1 = Peru: 2 = India (Burma); 3 = Argentina; 4 = Colombia; 5 = Poland; 6 = Trinidad; 7 = Sarawak.
The 1933 diagram ignores the smaller producers.

The Principal Oilfields of the World.—It is a matter of the greatest difficulty to give a general account of the oilfields of the world, since development is so rapid that any account must be out of date almost as soon as it is written. As an example,

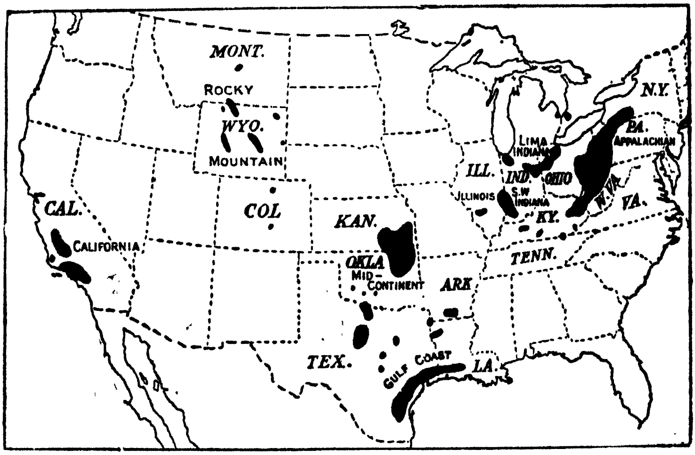
MONT.
ROCKY
WYO.
MOUNTAIN
COL
CAL.
CALIFORNIA
KAN.
OKLA
MID-CONTINENT
ARK
TEX.
GULF COAST
LA.
ILL.
ILLINOIS
IND.
S.W INDIANA
LIMA INDIANA
OHIO
KY.
TENN.
W.VA.
VA.
PA.
APPALACHIAN
N.Y.

FIG. 169.—Map showing the principal oilfield areas of the United States.
The actual oilfields lie within the black areas.

two fields—Santa Fè and Long Beach—which produced nearly 25 per cent. of the United States total, and 15 per cent. of the world's output in 1923, were virtually unknown two years previously, and three years later had dropped to the position of secondary producers. This account should be kept up to date by reference to *The Mineral Industry.*

United States.—The oilfields of the United States, as shown in Fig. 169, fall into a number of natural groups :

(1) *The Appalachian Fields.*—These fields cover largely the same area as the Appalachian Coalfields—from New York State in the north-east to Tennessee in the south-west. The most important area lies in Pennsylvania which, in 1885, supplied 95 per cent. of America's oil. The oil comes from Carboniferous rocks, and there are large numbers of natural gas wells. Production, 1933, 3·9 million tons.

(2) *Illinois and South-West Indiana Fields.*—These fields lie in the Illinois Coalfield region. Again the oil is from Carboniferous rocks. Production in 1933 was 0·7 million tons.

(3) *The Lima-Indiana Fields.*—These fields lie south of the Great Lakes in Indiana and Ohio. Production in 1933 was 0·15 million tons. Michigan Fields yielded 1·1 million tons in 1933.

(4) *The Mid-Continent Fields.*—This important group of fields lies mainly in the States of Kansas, Oklahoma, and Northern Texas. Many of the fields are remarkable for the enormous output reached within a few months of discovery. The production in 1933 was 84·9 million tons.

(5) *Gulf Coast Fields.*—These fields lie not far from the coast of the Gulf of Mexico, in the States of Texas and Louisiana. Production in 1933 was 10·8 million tons.

(6) *Rocky Mountain Fields.*—These fields extend over a wide area, but lie mainly in the State of Wyoming. Production in 1933 was 2·1 million tons.

(7) *Californian Fields.*—California is now the leading oil-producing state in America, and has witnessed an amazing series of spectacular discoveries. This was especially the case in the Los Angeles Basin. The oil industry has been the main factor in the rise of Los Angeles to the position of premier city on the Pacific Coast, whilst crude oil from California has been the most important single commodity passing through the Panama Canal. Production in 1929 was 40·6 million tons, but in 1933 only 24·7 million.

Mexico.—The important Mexican Fields have been developed by American and British capital since 1904, and in 1921 Mexico produced 29 per cent. of the world's total. After long holding second place, in 1933 Mexico had dropped with 2·5 per cent. to sixth place amongst the world's producers. The fields lie near the Gulf Coast, around the great oil ports of Tampico and Tuxpan.

Canada.—Canada's present small production comes mainly from southern Ontario and Alberta, but extensive fields are believed to exist in the frozen north, and expansion in Alberta is likely.

South America.—The countries of South America are now rapidly assuming great importance in the production of oil. In Venezuela extensive fields lie round the shallow Gulf of Maracaibo, producing 8·5 per cent. of the world's total in 1933 ; Peru, Argentina, and Colombia are yielding rapidly increasing supplies, whilst important oil-pools are exploited in the British island of Trinidad. The principal fields are indicated on the world map, Fig. 170.

Europe.—Europe, on the whole, is poor in oil. Excluding Russia, the principal fields lie on the outer flanks of the Carpathian Mountains in Galicia (Poland) and Rumania. Germany has several wells in Hanover, whilst France carries on the mining of certain oil sands at Pechelbronn. Prospecting in Great Britain has proved a failure.

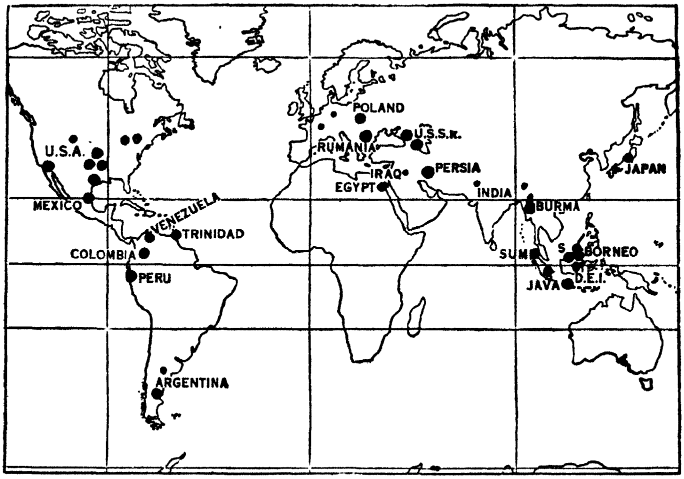

FIG. 170.—Map of the world showing the principal oilfields.
Sum. = Sumatra; S = Sarawak (British). D.E.I. includes Java, Sumatra and part of Borneo.

Russia.—Russia has both a rapidly increasing output (11 per cent. of world in 1933) and extensive reserves. The most important regions lie on either side of the Caucasus, notably around Grozny and Baku.

Persia.—A very important field has been developed by the Anglo-Persian Oil Company at Maidan-i-Suleiman in the south of Persia. An extension of the same oil belt is known to extend into Mesopotamia.

India and Burma.—The oilfields of Burma lie in the heart of the country and have been exploited for a considerable period, The bulk of British India's total comes from Burma, but there are small fields in the Punjab and Assam.

Dutch East Indies.—Important fields lie in Java, Sumatra, and Borneo, and also in the British territory of Sarawak.

Japan.—Japan's small production is insufficient for her needs.

Africa and Australia.—Australia has no oil, Africa is also devoid of oil except for some small fields in Egypt on the shores of the Red Sea.

World Trade in Petroleum and Petroleum Products.—One of the remarkable features of world trade in petroleum is the enormous import of crude oil into the United States—largely from Mexico. Although there is a huge export of refined products, the exports scarcely balance the imports, so that despite her enormous production, the United States' consumption is even greater. The leading exporting countries are Mexico, the Dutch East Indies, the South American countries, and Persia. Russia is now again becoming important as an exporter. Burma's output is absorbed by other parts of India. The leading importers are the United Kingdom, Canada. and the European countries. The trade in crude oil, mainly for bunkering, should be distinguished from that in petrol, lighting oils, lubricating oils, candle wax, and other products. The ubiquity of the motor car has resulted in a very widespread trade in petrol.

Oil-Shale.—The growing scarcity of new supplies of natural petroleum will doubtless result, in the near future, in the exploitation of the world's resources of oil shale. The shale needs to be mined and the oil obtained by destructive distillation—a process too expensive whilst supplies of liquid petroleum keep prices low. A more economical proposition at present is the treatment of low-grade coal or lignites, many of which yield as much as 100 gallons of crude oil per ton.

WATER-POWER

Running water has been utilized by man as a driving force from the early days of his civilization. Many towns to-day owe their position to the presence of a stream sufficiently swift to operate the water-wheel of the first mill. Geographers have traced out the "Fall line" in the eastern states of America, and amongst the important towns situated along it may be noted Columbia, Raleigh, Richmond, Hartford, Lowell, and Manchester. But it is only in recent years that water-power has assumed a new and greater significance. The fact that electricity when generated can be transmitted scores or even hundreds of miles has rendered of supreme importance many waterfalls and rapids situated in regions too remote from supplies of raw material or from main lines of communication to become industrial centres.

Water-power resources are naturally greatest in hilly or mountainous regions—giving a big fall of water—where there is a heavy or constant rainfall. On the other hand, oil occurs in young, soft rocks, and, therefore, mainly in lowland regions; coalfields are usually found in lowland rather than mountainous tracts. It follows that water-power is often most abundant in those countries which have few or no resources of coal or oil. Excellent examples are afforded by Norway and Switzerland. In the larger countries water-power is often available in those parts where both coal and oil are wanting—Canada, the United States, and France afford examples.

Water-Power Resources of the World.—All estimates which exist of the water-power resources of the world must be regarded as merest approximations. A great variety of bases for calculation have been adopted; in some cases it must also be remembered that estimates include water-power available in very remote and almost inaccessible regions. In order to compare water-power resources with coal resources, it may be mentioned that "a saving of coal of six tons per annum is capable of being effected by each installed horse-power." (Memorandum from the Water-Power and Reclamation Service of the Dominion of Canada.)

Thus Canada's 7,045,000 installed horse-power represents a saving of about 42,300,000 tons of coal per annum.

WATER-POWER OF THE LEADING COUNTRIES [1]

Countries	Undeveloped (in H.P.)	Turbine horse-power installed as in 1930	
		Total	Per head of population
United States	38,110,000 [1]	15,913,000 [3]	0·129 [1]
Canada	33,617,000 [2]	7,045,000 [2]	0·67 [2]
France	5,400,000	2,300,000	0·055
Italy	3,800,000	4,840,000	0·118
Norway	9,500,000	1.900,000	0·680
Switzerland	2,500,000	2,300,000	0·575
Japan	6,000,000	3,500,000	0·055
Sweden	5,000,000	1,675,000	0·279
Spain	4,000,000	1,000,000	0·043
Germany	2,000,000	2,000,000	0·032
U.S.S.R.	—	700,000 [4]	0·004

[1] From the *Commerce Year Book*.
[2] 1934.
[3] 1933.
[4] 1935 (est.).

In addition to the above countries, important developments have taken place in recent years in Australia (especially Tasmania) and in New Zealand. Extensive schemes are now being carried out in Northern India.

United States.—The most important installations in the United States are those utilizing Niagara Falls and supplying such towns as Buffalo and Rochester, and a large part of the State of New York. California is well supplied by numerous works using the streams flowing down from the Sierra Nevada. A large number of the industrial towns in the New England States have hydro-electric power—such towns as Manchester, Lawrence, Lowell, Fall River, Holyoke, and Hartford. The old water-mill towns of the Atlantic Coast States now have hydro-electric power—Columbia, Raleigh, Washington, Baltimore, Philadelphia, Trenton, and Paterson may be specially mentioned. South of the Great Lakes hydro-electric power is used at Minneapolis and St. Paul and at Dayton in Ohio. The Rocky Mountain States, especially Washington, Montana, and Idaho, are well supplied with water-power, as yet but slightly utilized.

Canada.—Canada is particularly fortunate in her large reserves of water-power. Practically every large industrial centre is now served with hydro-electric energy; water-power supplies 90 per cent. of the prime motive power of the central electric stations, whilst the success of the pulp and paper industry depends almost entirely on hydro-electric power. At present power is developed from Niagara Falls and from numerous falls and rapids in the forest belt of Southern Ontario and Quebec, and also in British Columbia.

France.—France has utilized most of the readily available sources of water-power along the Pyrenees, in the French Alps, along the Rhône Valley, and in the Central Massif.

Italy.—Italy utilizes the water-power available along the southern slopes of the Alps, as well as along the Apennines.

Norway and Sweden.—Norway's very large *per capita* development of hydro-electric power is the foundation of her successful chemical industry, and the same is true of Sweden. Neither country has any coal or oil. In the north, the streams become icebound in the winter and their utilization is greatly hindered. The same is true, it may be noted, of Northern Canada.

Switzerland.—In the absence of coal and oil, Switzerland has made the most of her excellent water-power resources from the Alps. Not only are her factories electrically run, but a large proportion of the Swiss railway system is electrified.

Germany.—Germany deserves special mention because, though possessing only limited resources of water-power, she has developed them to the fullest possible extent. This is evidenced by the small figure quoted for " undeveloped power."

Australia and New Zealand.—The important hydro-electric installations in Tasmania and New Zealand are dealt with in Part II.

Africa.—It is impossible here to detail the immense undeveloped water-power resources probably available in South America, Africa, and Asia. As an example of the present state of affairs we may instance the Victoria Falls in Rhodesia. The Falls could probably develop a greater horse-power than even Niagara, yet remain at present untouched, being too far from the present seats of industry. The important "Victoria Falls Power Company" thus awaits the march of progress and in the meantime generates electricity to supply the Johannesburg region by using local coal.

EXERCISES

1. Bring Figs. 159, 160, and 165 up to date from the *Mineral Industry* or the *Statesman's Year Book.*

2. Bring Figs. 167 and 168 up to date from the *Mineral Industry* or the *Statesman's Year Book.*

3. Draw sections through a typical coalfield and a typical oilfield, contrasting the disposition of the strata and the position of the workings.

4. Work out details of international trade in oil and oil derivatives for any recent year (*Statesman's Year Book*).

5. Keep up to date the table showing water-power development (details must be collected).

6. Construct a map of the world, showing the positions of the principal oilfields, marking against each the production in the most recent year of which figures are available.

EXAMINATION QUESTIONS

1. State the conditions and epochs which have favoured the formation of coals and the general character of such deposits. Account for the preservation of coal in the chief mining regions of Great Britain at the present time. (*Univ. Sheffield Inter. Hons.*, 1925.)

2. Discuss the probable origin of petroleum and the conditions most favourable for its accumulation, and mention the world's chief oilfields. (*Univ. Sheffield Inter.*, 1926.)

3. Discuss the factors affecting the present and probable future supply of petroleum. (*Univ. London B.A. Hons. Econ. Geog.*, 1927.)

4. Describe the distribution of the principal oilfields of the world and give some account of the political significance of their situation. (*Univ. Bristol Inter.*, 1927.)

5. Give an account of the world distribution and present production of mineral oil. (*Univ. London Inter. B. Com.*, 1927.)

6. What are the chief sources of mechanical power at present? How far is Australia likely to become a manufacturing country? (*Univ. Bristol Inter.*, 1926.)

7. Examine the various conditions making for or against the increased use of water-power in the near future. (*Univ. Bristol Inter.*, 1925.)

8. "Climate controls the distribution of raw material but not the manufacture of the finished product."

Expand and criticise this statement. (*Univ. Bristol Inter.*, 1926.)

9. Discuss the location of the great industrial cities in relation to coalfields with particular reference to such cities in Great Britain and North America. (*Univ. Bristol Inter.*, 1926.)

10. (*a*) What continent has the greatest potential water-power resources? Name four geographic factors which are responsible for this.

(*b*) "The St. Lawrence river is the finest natural water-power site in the world."

(1) State the arguments advanced in support of this statement.

(2) What proposed scheme may possibly result in the development of much of the available power on this river in the near future? (*Prov. Alberta Matric.*, 1927.)

11. How is coal formed? Say what you know of the disposition and importance of the coalfields of the United States or Great Britain. (*Univ. Rangoon Inter.*, 1926.)

12. Make a comparative study of coal and oil as sources of power, illustrating your answer by reference to specific examples. (*Asst. Insp. Taxes, G.B.*, 1927.)

13. How far is the U.S.A. a serious rival of Great Britain as a coal-exporting country? (*Asst. Insp. Taxes, G.B.*, 1927.)

14. Indicate the importance of coal in world trade. (*Univ. London Inter. B. Com*, 1923.)

15 Discuss the distribution of petroleum outside Eurasia. (*Univ. London Inter. B Com*, 1923)

16 Describe shortly the distribution of mineral oil outside the United States of America (*Univ. London Inter. B. Com.*, 1923.)

17. Compare the distribution and the importance of the Belgian and the Polish supplies of coal. (*Univ. London Inter. B. Com.*, 1928.)

18. Describe shortly the distribution of coalfields in Continental Europe outside Western Germany, Belgium and France. (*Univ. London Inter. B. Com.*, 1929.)

19. Under what conditions does mineral oil occur? Describe briefly its distribution in the countries of the world. (*Univ. London Inter. B. Com.*, 1929.)

20. Give an account of recent changes in the output of mineral oil in the world. (*Univ. London Inter. B. Com.*, 1930.)

21. In the case of *two* of the following areas, analyse the geographic conditions which have made the development of water-power possible and show for what purposes it is important: (1) French Alps; (2) Sweden; (3) Switzerland. (*Univ. London Inter. Arts*, 1930.)

22. Give an account of the principal modes of occurrence of mineral oil in nature and add a brief summary of the present production of oil in the world. (*Univ. London Higher Schools E*, 1932.)

23. "The coalfields of Britain are so situated as to favour in a remarkable way the development of a coal export and bunker trade." Examine this statement critically and compare the situation in Britain with that in *either* the United States *or* continental Europe. (*Univ. London Inter. B.Sc.* (*Econ.*), 1932.)

24. Give a geographical account of the distribution of the major coalfields in *either* continental Europe *or* the United States. (*Univ. London Inter. B.Sc.* (*Econ.*), 1933.)

25. Write a general account of the mineral and power resources of *one* of the following areas:—(*a*) New Zealand, (*b*) the Union of South Africa, (*c*) Argentina, Brazil, and Chile. (*Univ. London Inter. B.Sc.* (*Econ.*), 1933.)

26. Describe and account for the distribution of water-power in *either* Canada east of the longitude of Winnipeg, *or* Europe north of the Alps. (*Univ. London Inter. B.Sc.* (*Econ.*), 1934.)

CHAPTER XII

METALS

THERE are certain fundamental differences between the production, distribution, and consumption of commodities belonging to the mineral kingdom and those belonging to the animal or vegetable kingdoms. One of these has already been mentioned in connection with coal. Whereas the supply of a commodity of animal or vegetable origin is normally renewed by nature from year to year, a mineral deposit when " worked out " is not renewed, and the continuance of supply depends upon the discovery of new sources. The normal production curve of a vegetable or animal commodity shows, over a long period, a steady rise coincident with the increase in population or development of a country. Only in a few of the older countries has the maximum been reached. The production curve of a mineral commodity may, provided the resources of the country be great, show similar features. This is the case with coal in the United States. On the other hand, the rich surface mineral deposits easily found may soon be worked out, and unless new deep-seated supplies are found, the production curve will show a marked decline. This is particularly the case with the precious metals, especially gold. The discovery of gold has so often resulted in a gold rush and a rapid rise in output followed by an exhaustion of the rich surface deposits and a consequent drop in production that this course of events may be regarded as normal. It is instructive to compare the production curves for wool (*e.g.* in New Zealand) and gold (*e.g.* in Australia).

In the second place, man must eat to live, and many of the vegetable and animal commodities are essential foodstuffs of which the supply must be maintained. The mineral commodities, whilst scarcely to be classed as luxuries, are not so vital at all times. Supply and demand tend to fluctuate much more widely than is the case with foodstuffs. In times of prosperity there may be a very big demand for metals for constructive purposes ; periods of slump may result in a virtual cessation of the demand and consequently, in the long run, of the supply. Generally speaking, there was a huge demand for metals for munitions during the war and an inflation of prices. This phase was followed by a world-wide slump in 1920–21, a recovery to a high peak in 1929, followed by the disastrous depression reaching its lowest levels in 1932 and 1933.

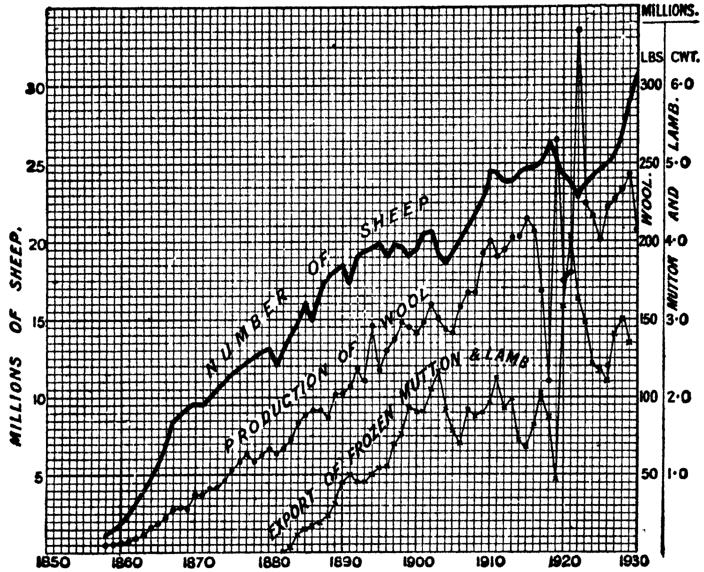

FIG. 171.—Graph showing the production of wool in New Zealand, also number of sheep and export of meat.

A graph typical of the expansion of an agricultural or pastoral industry in a new country.

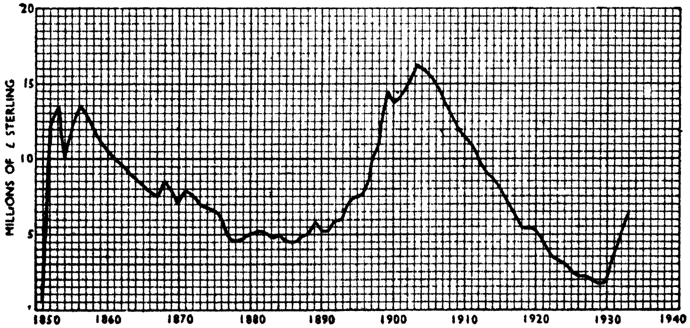

FIG. 172.—Graph showing the production of gold in Australia.

Contrast this with the last diagram.

We have only space here to consider a few of the more important mineral commodities.

IRON AND STEEL

Iron does not occur pure in nature, but the ores of iron are particularly widespread. It is, indeed, calculated that iron is the fourth most abundant element in nature, and constitutes 4·5 per cent. of the earth's crust. Iron ores are, therefore, found in a great variety of rocks. Only the larger deposits, or those particularly rich in metallic iron, or those readily accessible, are commercially important. Chemically, iron ores may be grouped into four classes:

(*a*) Sulphide ores, of which iron pyrites (FeS_2) and copper pyrites ($CuFeS_2$) are the most important. The former is often more important as a source of sulphur than of iron; the latter as a source of copper.

(*b*) Iron oxides, of which hæmatite (red ore) (Fe_2O_3) and magnetite (black ore) (Fe_3O_4) are the chief. These are the purest forms of ore; hæmatite may yield up to 70 per cent. of its weight of iron, and magnetite as much as 72·4. Both may occur as huge masses associated with igneous or metamorphic rocks, or in smaller quantities in veins. Hæmatite also occurs in masses in limestone districts.

(*c*) Iron carbonate usually occurs in impure beds—mixed with much clay in clay ironstone or carbonaceous matter in blackband ironstone—amongst sedimentary rocks. Whether such deposits are commercially valuable depends not only on the percentage of iron but also on the size and accessibility of the deposits.

(*d*) The hydrated oxides, of which limonite (brown ore) is the chief, occur, like the last group, mainly in an impure form as beds amongst sedimentary rocks. Although impure and sometimes yielding as little as 10 per cent. of metallic iron, the brown ores often occur in thick beds near the surface over huge tracts of country and therefore forming most important sources of iron. This is true of the Cleveland (Yorkshire) and Midland Fields of England and of the vast Lorraine ores.

The impurities present in the ore may affect the character of the iron. Phosphorus renders iron brittle and phosphoric iron ore needs special treatment; small quantities of manganese or chromium are beneficial; small quantities of copper render the iron useless. It is very usual for countries which produce enormous quantities of inferior ore suitable for the manufacture of iron sufficiently good for most purposes to import small quantities of purer ore for special purposes. Great Britain is a case in point, the imports of pure ore being from Sweden for cutlery manufacture, etc., whilst the great shipbuilding industry is built up on the existence of local supplies.

Iron and Steel.—The poorer quality iron ores are subjected to a preliminary "roasting" to remove certain volatile impurities. The concentrated ore is then mixed with a flux—usually limestone—and fuel (coke or coal) and smelted in a blast furnace. Smelting is usually carried out on the coalfields because of the large quantity of fuel used and the cost of transporting it. The United States' iron-towns along the shores of Lake Erie afford a special case of the ore and the coal being sent to meet one another, return cargoes of ore being taken to the coalfield where there is another iron-smelting centre (Pittsburgh). Electric smelting is being more and more used. In the blast furnaces the metal sinks and is run off into moulds as "pig iron." Pig iron may be regarded as a "raw metal"—though that term is never used—and contains such impurities as carbon, sulphur, and phosphorus. Pig iron may be used direct

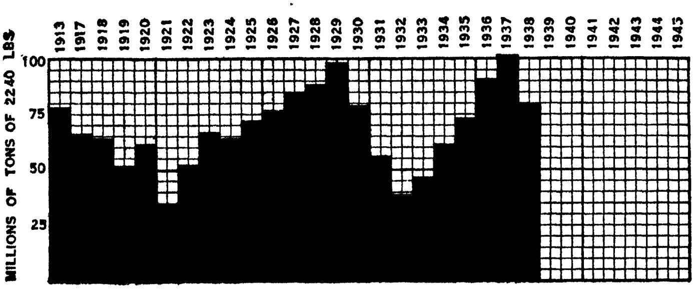

FIG. 173.—World production of iron.

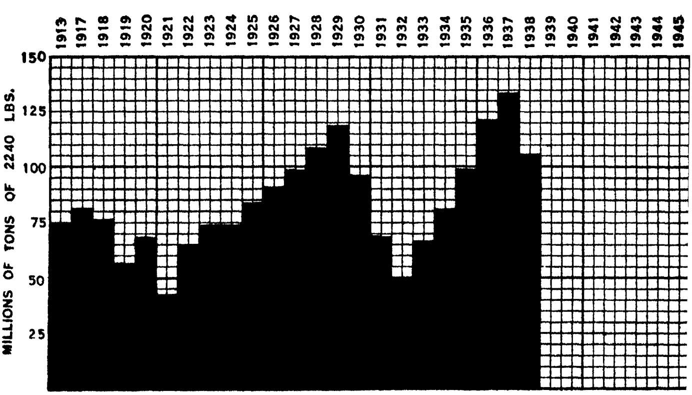

FIG. 174.—World production of steel.

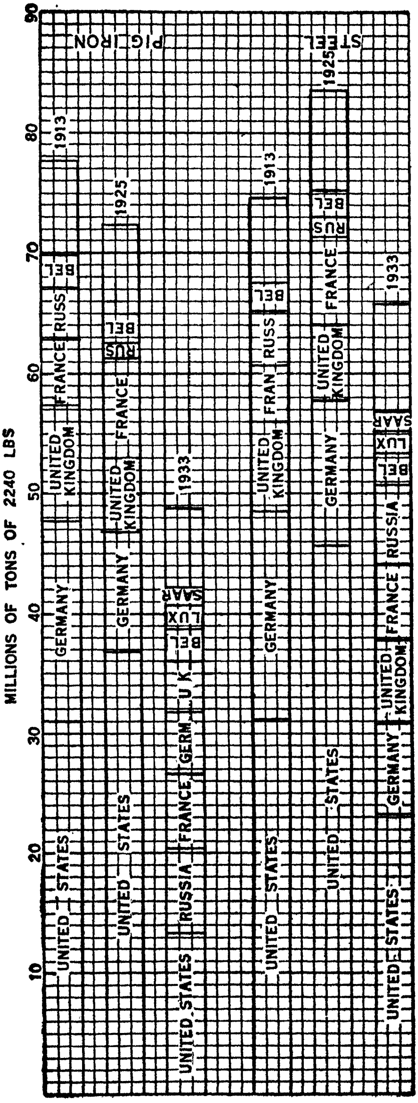

FIG. 175.—Production of iron and steel in the principal countries.

and the carbon burnt out by the process known as "puddling." The iron can then be hammered into "blooms" (bars) or rolled into sheets and bars of "wrought iron"—which is much tougher than pig iron. The better quality steels are made from wrought iron by the reintroduction of a small quantity of carbon. Ordinary steels are made direct from pig iron, either by the Bessemer process or the "open-hearth" system, manganese being added in the form of ferro-manganese in the process. Phosphorus, even in the smallest quantities, is a highly undesirable impurity in steels, and is usually removed by what is known as the "basic process"—lime being added to the lining of the converter in the Bessemer process. Special types of steel are made by adding various other metals in small quantities. Nickel, manganese, chromium, and tungsten are among the more important metals used in that way.

World Production of Iron Ore, Iron and Steel.—Although statistics of the production of iron ore are published for many countries, from what has been said of the varying quality of iron ores it will be apparent that ore production does not afford an adequate index of iron and steel production. Figs. 173 and 174 have therefore been drawn to show the world production of iron and steel in recent years. The 1921 "slump" is very marked in both cases. Fig. 175 indicates the principal producing countries.

The Principal Iron-producing Countries.—*United States.*[1]—The total output of iron ore from the United States is now about a third of that of the whole world, the production of pig iron has ranged in the years 1917 to 1930 between 40 (1930) and 60 per cent. of the whole and the production of steel also between 40 (1930) and 60 per cent. These figures compare with 40 per cent. for pig iron and 42 for steel in 1913.[2]

Out of 75,600,000 tons of iron ore, valued at $197,000,000, mined in 1929, no less than 83 per cent. came from the Lake Superior district.[3] There are two main areas, the one in Minnesota (70 per cent.), the other in Michigan (30 per cent.). In the former state the ore occurs in the Mesabi (two-thirds of the Lake Superior output) and Vermilion ranges, and less from the Cuyuna range; in the latter, in the Gogebic, Marquette, and Menominee ranges. The ore is mainly hæmatite. The bulk of the ore mined is shipped by water; Duluth, Superior, and Two Harbors being the great iron-ore ports of Minnesota; Ashland, Marquette, and Escanaba the iron-ore ports of Michigan. The ore is distributed to the three great iron and steel industrial centres:

(*a*) The Michigan lakeside towns north and south of Chicago.
(*b*) The Erie lakeside towns east and west of Cleveland.
(*c*) The Pennsylvanian Coalfield around Pittsburgh.

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[1] Figures for U.S. and Great Britain in tons of 2,240 lbs.

[2] The United States suffered particularly badly from the depression and the percentage fell to 22 and 27 in 1932.

[3] During the depression the figures fell to 24,600,000 tons valued at $63,800,000 in 1933.

Another important producer of iron ore is the State of Alabama, in the South Appalachian Coalfield region, near Birmingham.

No other state has an average production (1920–34) exceeding a million tons of ore. In some years Wisconsin, New York (in the Adirondacks), and Pennsylvania approach that total. As in Great Britain the coal measure iron ores are no longer important in the older coalfields.

Despite the enormous production, imports of iron ore into the United States exceed the exports. The imports are derived mainly rom Chile, Cuba, Sweden, Spain, and French Africa. In 1923–36 production of pig iron in the United States averaged 37 million tons, of steel 46 million tons ; exports of iron and steel 1·76 million tons.[1]

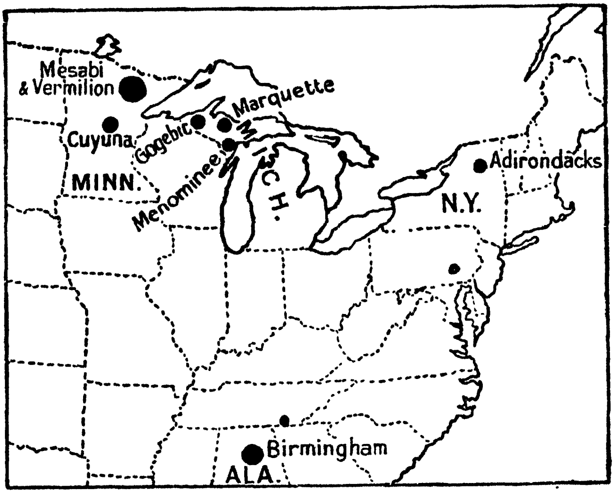

FIG. 176.—Iron ore in the United States.

Great Britain.—Great Britain's iron and steel industry was built up to a considerable extent, in the first instance, on the occurrence of black band ironstones in the coalfields. The close association of coal and iron ore, so often argued in text-books, is now largely a myth. Only in one instance—Staffordshire—is there still a considerable output of ore from a coalfield region. The bulk of British iron-ore supplies comes from two sources :

(*a*) The bedded, low-grade ores of Jurassic age, worked in the Cleveland Field of North Yorkshire and in Lincolnshire and Northamptonshire.

(*b*) The excellent quality hæmatites, occurring as great masses in limestone in Cumberland and North Lancashire.

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[1] In 1929–33 the figures were pig 23, steel 32, exports 1·48

In 1910–13 the average production of pig iron in Great Britain fluctuated between 8·9 and 10·5 million tons. The depressed state of the industry is indicated by the very low post-war production, sinking as low as 2·6 million tons in 1921. It rose to 7·6 in 1929, but fell during the great depression to 3·7 in 1931, rising to 6·0 in 1934. Steel production in 1923–25 averaged 8·0 million tons. In 1929 production rose to over 9·6 million tons, dropped to 5·0 in 1931, rising to 8·9 in 1934.

Great Britain only produces about two-thirds of her requirements of ore. The demand is mainly for better quality ores. Large quantities are shipped from Northern Spain and Algeria to South Wales; smaller quantities of magnetite—excellent quality ore, suitable for fine cutlery steels—from Sweden *viâ* the Norwegian port of Narvik to the Sheffield district of Yorkshire. The iron and steel industry of Britain is still concentrated on the coalfields:

(*a*) The Northumberland and Durham Coalfield, centring on Newcastle and the other Tyneside ports.
(*b*) The Yorkshire Coalfield, centring on Sheffield.
(*c*) The South Staffordshire Coalfield and Birmingham.
(*d*) The South Wales Coalfield, specializing in tin plate (Swansea and Cardiff).
(*e*) The Lanarkshire Coalfield and Clydeside area of Scotland, centring on Glasgow.

It should be noted that the very important Tees-side smelting area, centred on Middlesbrough, is not on a coalfield. There is also marked specialization in the various areas.

The export of pig iron from Britain is not large, but of steel the export has, in recent years, approximated to half the total production.

France.—Apart from a production of between ½ and 1¼ million tons of ore from Normandy and small quantities from the Pyrenees and small scattered fields, the bulk of France's iron ore comes from the great Lorraine Fields. In 1913 only the Briey-Longwy and Nancy portions lay in French territory; the more important Metz-Thionville area then lay in German territory. In 1913 the latter alone produced over 21,000,000 metric tons of ore—nearly as much as the whole of France at that time. The normal output of the whole Lorraine area (excluding Luxembourg) may be regarded as in the neighbourhood of 40 million metric tons. Actually it rose steadily from 13¼ in 1921 to 33¾ in 1925, and to 43 n 1927; in 1929 the output reached 48 million metric tons, but fell to 26 in 1932.

The adequate utilization of Lorraine iron ore is intimately bound up with the possession of an adequate supply of fuel. This France had from 1921 to 1935 in the Saar (Sarre) Coalfield—even that was scarcely sufficient. Now the Saar Field is restored to Germany the position is that France has the ore, Germany the fuel. The Lorraine ores are low-grade sedimentary ores with a high phosphoric content.

Germany.—Apart from the lost Lorraine Fields, Germany has considerable deposits of iron ore in Siegerland and Vogelsberg and the Peine and Salzgitter areas. These home supplies are totally inadequate, however, to maintain Germany's great iron and steel industry built up before the war. In 1925, 11·5 million tons of iron ore were imported, 7·4 coming from Sweden, 1·4 from Spain, 1·6 from the Lorraine Fields. In 1929 17 million metric tons were imported, but in 1934 only 4·6. The important Upper Silesian iron-ore field is shared with Poland.

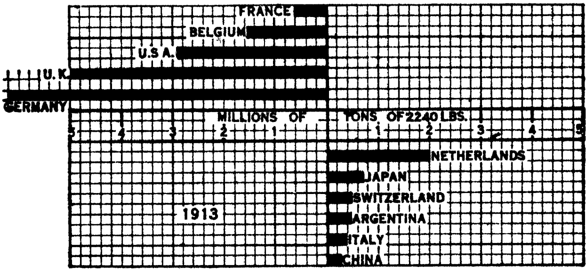

FIG. 177.—World trade in iron and steel, 1913.

Spain.—Spain is rich in iron ores; the principal areas of production are along the northern coastal strip around Santander and Bilbao, and in the south around Almeria. With a production of good quality iron ore in 1929 of 6·6 million tons the output of iron and steel is less than 1½ million tons, indicating the large export of ore. The ore is sent specially to Britain and Germany.

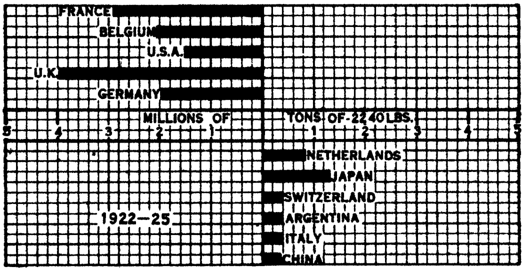

FIG. 178.—World trade in iron and steel, 1922–25.

The quantities shown for the importing countries in Figs. 177 and 178 must be regarded as very approximate, owing to the varied classifications adopted by the various countries. Thus some include iron and steel and manufactures thereof together; others do not. The diagrams illustrate the concentration of production in five leading countries, and the wide distribution of the trade amongst importers.

Sweden.—In the north of Sweden there are several hills consisting of solid masses of pure magnetic iron ore (magnetite). The hills lie in the Gellivara or Norrbotten district, and much of the ore is exported through the permanently ice-free Norwegian port of Narvik. Another iron area lies in Southern Sweden (Kopparberg). In 1913 Sweden's output of ore was 7·5 million metric tons, in 1929, after severe depression, it had risen to 11·5 million (1933, 2·7).

Belgium and Luxembourg.—In Luxembourg and the extreme south of Belgium lies the extension of the Lorraine Fields. The very important Belgian steel industry is supplied with ore from this area and from France. The industry is concentrated on the Belgian Coalfield.

Russia.—Russia has important iron-ore fields in the Donetz Basin in the south, and in the Tula district of Central Russia.

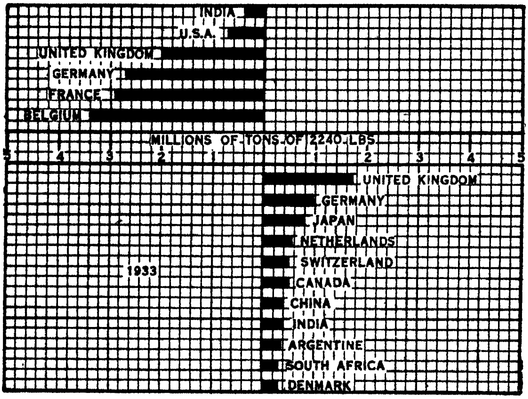

FIG. 179.—World trade in iron and steel, 1933.

Other Countries.—Amongst countries which have been developing a home iron and steel industry in recent years should be noted India and Australia. Further particulars are given in Part II. The very fine Italian iron ore from the Island of Elba, the extensive deposits at Eisenerz in Austria, and the increasing output of Chile are other points to be noted.

World Trade in Iron and Steel.—The outstanding feature of world trade is the important position occupied by the five main exporters. The position is indicated by Figs. 177 and 178.

World Resources of Iron Ore.—Estimates of the world's resources in iron ore were collected by the Eleventh International Geological Congress (1910). Details available are not nearly as complete as in the case of coal. It must be remembered, too, that as the richer and more accessible deposits become exhausted, there are vast stores of low-grade ores and deposits at present too remote for exploitation which will become available.

ALUMINIUM

Aluminium, being a very light yet strong metal, has become increasingly important with the rise of the motor-car industry. The amount of the metal used averages about 40 lb. per car (1925–26). Although a very common metal in nature the very high temperatures available in the electric furnace are required in reducing the ores to the metal, and there is a marked tendency for the production of aluminium to be restricted to those countries where hydro-electric power is available. Production is entirely controlled by five groups of producers—the American, German, Swiss, French, and British interests, operating in various parts of the world.

Production of Aluminium in Metric Tons

Country	1913	1925	1929	1933
United States	29,500	93,000	102,270	39,000
Germany	800	25,000	35,000	14,000
Norway	2,500	23,000	25,000	15,000
France	13,500	20,500	30,000	14,000
Switzerland	10,000	20,000	22,000	12,000
Canada	6,000	17,000	36,000	16,000
Great Britain	10,000	9,000	10,000	12,000
Austria	5,000	4,000	2,700	1,000
Italy	800	2,000	7,000	12,000
World Total	78,000	213,000	270,000	137,000

Norwegian production is now controlled by American, French, and British interests, that in Austria by Swiss. In Canada the new works on the Saguenay River are of great importance.

COPPER

The ores of copper are found mainly in veins in igneous and metamorphic rocks. The ores are widely distributed and the success of copper-mining enterprises depends very largely on demand. World production reached 1·9 million metric tons in 1929—a record up to that date. Over half the production is from the United States, whilst about 70 per cent. is controlled by American interests. 1918 production touched 1,402,000 metric tons; 1921 production dropped to 556,700, since when it rose steadily to 1929, and in 1932 the United States produced only 24 per cent. of the world total of 900,000 metric tons.

WORLD PRODUCTION OF COPPER IN METRIC TONS

Country	1918	1929	1933	1936	1938
United States . .	865,700	931,000	216,000	534,000	515,000
Chile	107,000	316,000	103,000	235,000	342,000
Japan	95,800	75,000	72,000	80,000	—
Africa (mainly Congo)	31,000	146,000	154,000	95,000[1]	126,000[1]
Spain and Portugal .	41,000	51,000	37,000	—	—
Mexico	75,500	79,000	40,000	—	—
Canada	53,000	110,000	136,000	165,000	262,000
Peru	45,000	54,000	23,000	—	—
Northern Rhodesia .	—	—	—	140,000	207,000
World (including others)	1,402,000	1,909,000	920,000	1,596,000	2,000,000

[1] Congo only.

Another important producer is Germany ; Australian production has shown a marked drop in recent years.

Reference should be made to Part II for details of the areas of production.

GOLD

Gold is one of the most stable of metals and is usually found native in nature. Gold-bearing deposits fall into two broad classes :

(1) Reef or lode deposits, associated usually with igneous rocks. The gold-bearing rock (usually consisting mainly of quartz) is mined and has to be crushed before the gold can be extracted.

(2) Alluvial or placer deposits, which represent deposits laid down by streams emanating from gold-bearing country. The native gold has been washed out of the parent rock and, being very heavy, has become concentrated in " pay streaks " at or near the base of the sands or gravels. The gold occurs as dust or sometimes as " nuggets." Unless the gold-bearing alluvial deposits are very extensive, these superficial gold areas are very quickly worked out.

The most important of all the gold-bearing deposits in the world, the famous bankets or reefs of the Witwatersrand, Transvaal, are curious deposits. They are ancient conglomerates, hardened to compact siliceous masses, in which the gold is so finely disseminated as to be absolutely invisible to the naked eye. It is removed by chemical means after the crushing of the banket.

The gold production of the world remains comparatively steady from year to year, as the following table shows :

WORLD PRODUCTION OF GOLD

Year.	$	£	oz.
1900	258,829,703	52,312,000	21,972,000
1910	453,766,523	93,332,000	—
1913	462,669,558	95,069,000	22,381,000
1921	330,232,000	66,000,000	15,538,000
1922	319,161,000	63,000,000	15,067,000
1923	369,716,000	73,900,000	17,398,000
1924	392,046,000	79,000,000	18,678,000
1925	389,251,000	81,000,000	19,069,000
1926	398,557,000	82,000,000	19,304,000
1927	402,158,000	82,000,000	19,304,000
1928	406,338,000	83,000,000	19,539,000
1929	403,366,000	82,800,000	19,586,000
1930	430,700,000	88,500,000	20,836,000
1931	461,600,000	94,500,000	22,329,000
1932	498,900,000	102,500,000	24,150,000
1933	522,200,000	103,500,000	24,962,000

Column showing value in dollars from *The Mineral Industry*; value in pounds sterling from *Statesman's Year Book*; production in ounces has been calculated on the basis of £4 24773=1 oz. 1934: 27,600,000 oz.; 1935: 30,500,000 oz.; 1936: 33,000,000 oz.; 1937: 35,500,000 oz.; 1938: 36,700,000 oz.

Fig. 180 has been drawn to show the principal gold-producing countries. The remarkable position occupied by the Transvaal should be noted.

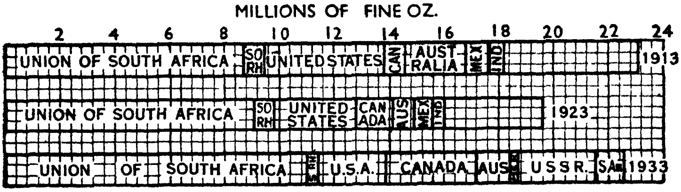

FIG. 180.—Production of gold in the principal producing countries.
So.Rh.=Southern Rhodesia; Can.=Canada; Mex.=Mexico; Ind.=British India.

Principal Gold-producing Countries of the World.—*The Transvaal (Union of South Africa)*.—Owing to the invisibility to the naked eye of the gold particles, the immensely valuable banket long remained undetected. It is now worked all along the Witwatersrand, east and west of Johannesburg, in deep mines. Huge reserves of ore still remain, districts further east are still being opened up, whilst mining can be pushed deeper in many localities.

Rhodesia.—Gold in Rhodesia is widely distributed and the possibilities of the country are by no means fully explored.

United States, Mexico, Western Canada, and Alaska.—Gold is widely distributed through the length of the Rocky Mountains from Alaska to Mexico. The peak of the United States production was reached in 1915 (4,887,602 ounces valued at $101,000,000) and dropped to an average in the years 1921–25 of less than 2,500,000 ounces. In 1927 it was 2,100,000 ounces, and in 1933 2,435,000 ounces. Gold-mining in the Rocky Mountains is the usual story of gold rushes, big production, the working out of deposits and the search for new. This is particularly the case with the big placer deposits. Thus the famous field at Dawson (Klondyke) in the frozen wastes of Yukon produced over a million ounces in 1900—four years after its discovery; but in 1924 the production had fallen to 35,000 ounces. Any account of the leading gold-mining areas may be entirely out of date in two or three years. In the United States the leading producers in 1929 were California, Alaska, New Mexico, Tennessee, Utah, Colorado, Nevada, and Arizona.

Eastern Canada.—Amongst the vast mineral resources, as yet only partly explored, of the Laurentian Shield of pre-Cambrian metamorphic rocks, gold takes an important place. The production of gold in Ontario has shown a steady rise from 2,000 ounces in 1911 to over 2¼ million in 1933, and there is every prospect of continued progress. The important centres are Porcupine and Kirkland Lake.

Australia and New Zealand.—A quarter or half a century ago Australia was the gold miners' Eldorado. From its discovery in 1891 the famous Kalgoorlie area alone produced gold worth £80,000,000. The State of Victoria alone produced over £300,000,000 worth of gold. But in 1925 the whole production of Australia had fallen to a little over half a million ounces; that of New Zealand was 130,000 ounces, the whole Australasian production being worth $14,200,000 or £3,000,000.

India.—India's production comes from the Kolar Goldfield of Mysore.

Siberia.—The normal output of Siberia is large; the important area being the Lena Goldfield north of Lake Baikal.

Japan, West Africa (Gold Coast), Belgian Congo, China, The Philippines, East Indies and *Central America* all had an output in 1929 exceeding or near $1,000,000 in value.

The Gold Stores of the World.—Much interest attaches to the position of the gold-holding countries of the world at the present time. In 1925 and 1936 they were estimated to be:

	1925 £	1936 £
United States	826,500,000	2,200,000,000
British Empire	252,000,000	400,000,000 [1]
France	220,000,000	600,000,000
Spain	100,000,000	—
Argentina	90,000,000	—
Italy	68,000,000	52,000,000
Germany	44,000,000	5,000,000 [2]

[1] Bank of England only.

[2] Reichsbank.

It is impossible here to enter into the complicated question of the consumption of gold. It may be noted, however, that there is a steady annual import into India where the mass of the population turns its savings into gold ornaments. There is a steady demand for gold for jewellery in most parts of the world.

SILVER

Although silver ores and deposits of native silver do occur in nature, a very large proportion (more than two-thirds) of the world's silver is obtained virtually as an impurity in lead ores—particularly in galena (lead sulphide). Thus the big production from Burma is entirely from a huge lead-zinc deposit. As shown in Fig. 181 the silver production of the world has remained relatively constant. The output exceeded 5,000,000 kgs. (160,000,000 ounces) for the first time in 1893; it has remained between that figure and 8,000,000 kgs. every year since, except for a slightly lower output in 1914. In 1929 the output was over 260,000,000 ounces worth $147,000,000, in 1933, 163,000,000 ounces. Fig. 182 shows the chief silver-producing countries of the world. The outstanding feature is the predominance of North America—Mexico, United States,

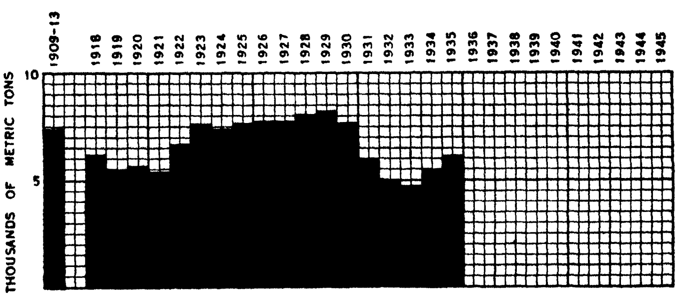

FIG. 181.—World production of silver.

One metric ton = 1,000 kgs. = 32,150 fine oz. troy approximately.

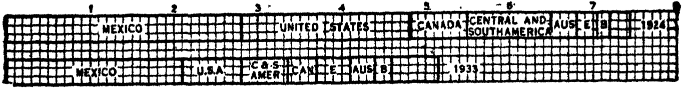

FIG. 182.—Production of silver in the principal producing countries.

AUS. = Australia; E. = Europe; B. = Burma. One metric ton roughly equals 32,150 troy oz.

and Canada; with South America occupying an important second place.

The Principal Silver-producing Countries of the World.—*Mexico, The United States, Western Canada, and Alaska.*—As with gold, the great silver-producing regions are concentrated in the Rocky Mountains from Alaska to Mexico. In Canada there are important mines in British Columbia sending their ore to the central reduction works at Trail, and another area in the Salmon River district.

In the United States the leading producers are Utah, Montana, Idaho, Arizona, Nevada, Colorado, and New Mexico (all producing over 1,000,000 ounces in 1933). Some of the deposits are silver-lead; others silver only or silver-gold. In Mexico many of the largest producers are mines producing silver only.

Central and South America.—The Rocky Mountain silver belt is continued through Central America into South America, where Peru and Bolivia are particularly important.

Eastern Canada.—Although the output of silver from Ontario has fallen of recent years, Canada as a whole may be regarded as the most promising gold and silver country in the world. There are big possibilities in many parts of the Laurentian Shield, as well as in the British Columbian areas of Western Canada already mentioned. Ontario's production is mainly from Cobalt.

Europe.—The silver production of Europe is mainly from Germany and Bohemia.

Asia.—India's considerable production (6,100,000 ounces in 1933) is from the Bawdwin mine, Burma. Japan and the East Indies have also an important output.

Australia.—The production was mainly by the silver-lead deposits of Broken Hill, N.S.W., but these were closed down in March, 1939.

The demand for silver for coinage is very widespread, and so is its use in electro-plating and in jewellery as well as in medicine and the arts.

LEAD

The bulk of the world's lead is obtained from the ore known as galena (lead sulphide). Galena is classed as argentiferous if it yields over 0·1 per cent. of silver. Galena is also associated with the sulphide of zinc (zinc blende), hence the frequent production of silver, lead, and zinc in a single mine. Nearly half the world's lead ores are found in veins, the other half as masses amongst limestones, the lead ore having chemically replaced the limestone.

Lead production in recent years is shown in Fig. 183 and the leading producers in Fig. 184.

Over 40 per cent. (22% 1933) of the world's lead is produced in

the United States. The leading areas are South-East Missouri and Joplin, and the Rocky Mountain States (notably Idaho, Utah, and Colorado). Australia's production is mainly from Broken Hill; India's production from Bawdwin (Burma); Spain's from Linares and Ciudad Real. Canada's large and increasing output is almost entirely from British Columbia, and the bulk of it passes through the reduction works at Trail.

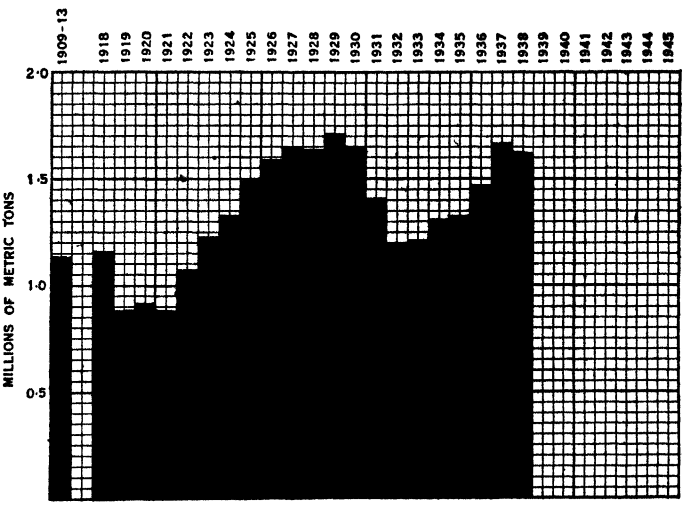

FIG. 183.—World production of lead (smelter output).

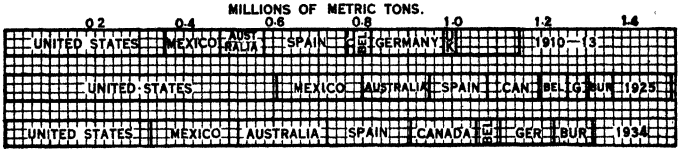

FIG. 184.—Production of lead in the principal producing countries.
C.=Canada; Bel.=Belgium; G.=Germany; Bur.=Burma.
Note: The 1934 diagram does not include the smaller producers.

ZINC

Zinc is obtained mainly from the sulphide ore, zinc blende, already mentioned as frequently associated with lead ores. The world's production in recent years is shown in Fig. 185, and the leading producers in Fig. 186.

The huge production of the United States—roughly 30 per cent. of

the world's total—comes mainly from three areas. The Joplin district—lying partly in Oklahoma partly in Kansas, and partly in South-Western Missouri—is responsible for one-half the whole. Second place is taken by Franklin Furnace (New Jersey), and third place by Butte in Montana. Australia's production is mainly from Broken Hill (N.S.W.) and Mount Zeehan (Tasmania). The upper Silesian deposits account for the large output of Poland and part of that of Germany.

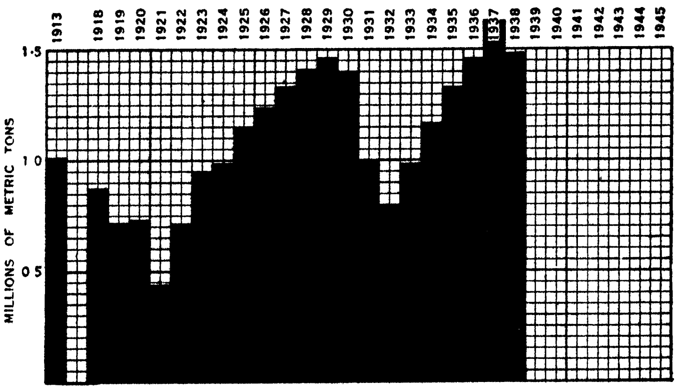

FIG. 185—World production of zinc (smelter output).

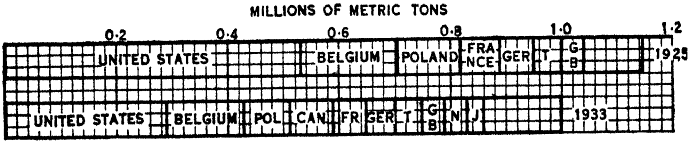

FIG. 186.—Production of zinc in the principal producing countries (smelter output).

Ger. = Germany. T. = Tasmania; G.B. = Great Britain.

MANGANESE

Manganese is important in the steel industry in the manufacture of manganese steels. The leading producers are India, Brazil, and Russia (Georgia).

CHROMIUM

Like manganese, chromium is important in the steel industry. The production is shared by India, Rhodesia, Union of S. Africa, Yugoslavia, New Caledonia, Cuba, Greece, and Turkey. In the last two or three years Rhodesia has shot ahead to the premier position, Yugoslavia to second.

TUNGSTEN

Tungsten is also a metal used in hardening steel. There was a big demand for tungsten steels during the war, and tungsten mines were very active. The principal ore, wolfram, is often associated with tin ores in lodes. In 1919 production of wolfram (tungsten oxide) concentrates exceeded 20,000 metric tons. In the 1921 slump the production dropped to 5,600 tons. The big permanent producer is China, followed by Burma. The United States, Malaya, and Bolivia have shown themselves capable of a large output when prices are sufficiently high to encourage production. Production in 1933 was 14,000 tons.

NICKEL

Three-quarters of the world's nickel comes from the Sudbury district of Ontario, Canada, and much of the remainder from the French island of New Caledonia in the Pacific Ocean.

TIN

The principal ore of tin is the oxide, cassiterite. Cassiterite is a very heavy and a very stable mineral. Like gold, tin is therefore found in both alluvial deposits (stream tin) and in lodes. A large production is often obtained from alluvial and residual deposits, but ultimate resources are to be looked for in the parent rocks. For the past fifteen years there has been a steady world production (except during the 1921 slump) of between 120,000 and 190,000 tons. Production in 1929 was over 190,000 tons. It will be noticed in Fig. 187 that there is a remarkable concentration of production in the countries of South-Eastern Asia. Roughly two-thirds of the world's supply is from Malaya (Federated Malay States), Dutch East Indies (islands of Banka and Billiton), Siam, Southern Burma, and Southern China. The remainder of the world's supply comes mainly from the plateau of Northern Nigeria and the high plateau of the Andes in Bolivia. The small producers include Australia (with Tasmania), Great Britain (Cornwall), the Congo, and South Africa.

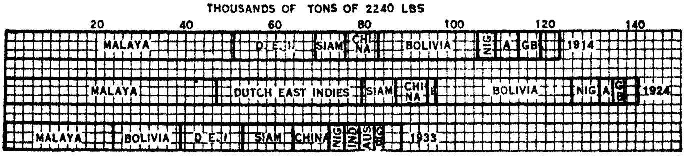

FIG. 187.—Production of tin in the principal producing countries.

I. = India (Burma); Nig = Nigeria; A = Australia; G.B = Great Britain (Cornwall).

NOTE.—Production in 1914 was slightly larger than the average for 1910–13.

It will be noticed that the United States does not appear amongst the producers. The United States is a big consumer, drawing supplies from Malaya, Bolivia, and the Dutch East Indies. The production of tin has been the subject of international agreements and restrictions.

OTHER METALS

Many other metals enter into commerce in limited quantities. **Platinum**, more valuable than gold, is now largely obtained from Canada, Russia, Colombia and South Africa. Many metals are used in small quantities to form alloys—*bismuth, molybdenum, antimony, vanadium, titanium,* and *cobalt* are examples, whilst *mercury* is important in the extraction of gold from its ores and in medicine.

MINERAL FERTILIZERS

Sodium Nitrate is a very soluble salt found in huge deposits in the rainless deserts of Northern Chile. The bulk of the production is exported and exports are normally between 2 and 2½ million tons. Nearly half the total export is taken by the United States, much of the remainder by Northern Europe and Egypt. There has been a very severe slump recently.

Calcium Nitrate is an artificial fertilizer produced in large quantities in Norway.

Sulphate of Ammonia is another artificial fertilizer produced where sulphur is available.

Potash Salts are mined in large quantities in Germany (Stassfurt) and in France (Alsace). Large quantities are sold to the United States, Great Britain, Holland, and Italy.

Phosphates.—Natural phosphates are produced in large quantities in Florida, Tunis, and Algeria, and in the Pacific Islands of Nauru and Ocean Island.

SALT

The world's production of salt is estimated at 20 million tons annually, distributed as shown in Fig. 188 (p. 237). Salt is obtained from three main sources: (*a*) rock salt mines, (*b*) brine obtained by wells, (*c*) evaporation of sea-water.

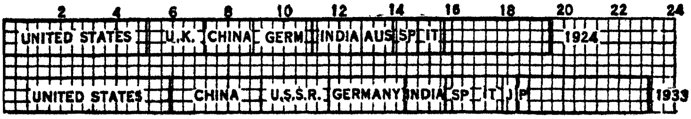

FIG. 188.—Production of salt in the principal producing countries.
U.K.—United Kingdom; Germ.=Germany; U.S.S.R.—Russia; Sp.—Spain; It.—Italy; J.—Japan; P.—Poland.

EXERCISES

1. Bring Figs. 173, 174, and 175 up to date. Figures from the *Mineral Industry*. Most essential figures may also be obtained from the *Statesman's Year Book*.

2. Draw up a table showing production, export and import of iron *ore* of the principal countries. Determine therefrom the home consumption and by contrasting the production of iron and steel in the same year, notice what conclusion may be drawn regarding the quality of the ores used.

3. Bring Fig. 179 up to date.

4. Bring Fig. 180 up to date. Collect figures to show the "trade in" or movement of gold in a recent year.

5. From the *Mineral Industry* construct diagrams or tabulate statistics to show (*a*) the trend of world production; (*b*) the production of the principal countries in (1) aluminium, (2) copper, (3) manganese, (4) chromium, (5) tungsten, (6) nickel, (7) asbestos, (8) potash salts. Use the figures also to complete the tables given under aluminium and copper

EXAMINATION QUESTIONS

1. Give an account of the distribution of iron ore in Europe with special reference to (*a*) output, (*b*) proximity to fuel for smelting purposes. (*Univ. Bristol Inter.*, 1924.)

2. State the chief sources of the world's supply of (*a*) nickel, (*b*) tin, and add notes on any geographical conditions that affect manufacture and distribution. (*Univ. Bristol Inter.*, 1925.)

3. Describe the main conditions under which iron ores occur; noting their relative economic value, their geological age, and typical regions where exploited. (*Univ. Sheffield Inter. Hons.*, 1925.)

4. Give an account of the geographical factors concerned in the present distribution of the iron and steel industry of the U.S.A. (*Univ. London B.Sc.*, 1927.

5. Indicate the position of the chief deposits of iron ore at present being worked in Europe, and explain the advantage or disadvantages of each. (*Univ. London Inter. B.A.*, 1909.)

6 Give an account of the iron and steel industry of U.S.A. (*Univ. London Inter. B. Com*, 1925.)

7. Supposing that there is satisfactory evidence as to the existence of large quantities of iron ore in some specified locality, indicate the types of geographical control which might decide whether such ore would be, or would not be, used in a specified blast furnace area. (*Univ. London Inter. B. Com.*, 1922.)

8. Under what conditions does tin ore occur in nature? Describe the methods of exploitation in the principal producing countries. (*Univ. London Inter. B. Com.*, 1930.)

9. Give a reasoned account of the development of the iron and steel industries of *either* the United States *or* Great Britain. (*Univ. London Inter. Arts*, 1930.)

10. Discuss the distribution and the importance of coal and iron in Japan. (*Univ. London Inter. Arts*, 1929.)

11. Discuss the accessible mineral wealth along the Pacific coast of South America. (*Univ London Inter. Arts*, 1929.)

CHAPTER XIII

INLAND TRANSPORT

HAVING now considered the principal commodities which enter into commerce, it is desirable to indicate some of the means whereby they are transported from one region to another.

The relative importance of the various means of transport should first be realized.[1] By far the most important is the railway. The rapid development of automobile construction in the last few years has revived the competition between road and railway for some classes of goods. Within a radius of 100 or possibly 200 miles from a populous centre it is now increasingly common for agricultural produce for the local markets to be collected by motor van and transported by road, thus dispensing entirely with the services of the railway. Similarly big city stores deliver by road within large areas. One of the great advantages of such service is delivery direct from warehouse to local retail store, or from the big city store to the customer's own door. Similarly the ease of travel direct from one residence to another has made road transport increasingly popular with the travelling public. Notwithstanding these recent developments, for all long-distance transport roads may be regarded essentially as "feeders" for the railway. The advent of the motor car has, in this sense, broadened the effective sphere of influence of a railway. In Central Africa coolies carrying loads cannot travel more than 20 miles a day; in India and Burma the recognized day's journey for a bullock cart—which travels at an average speed of 1¾ miles per hour—is 15 miles. Even over mere cart-tracks a day's journey of 60 or 100 miles is a matter of little difficulty for a one-ton motor-truck.

We have been accustomed, in the past, to hear much of the great advantages of inland waterways. It is true that a horse can drag a barge laden with forty tons along a canal, whereas one ton would be a good load on a cart along the road. For an equivalent load the motive power of a steamer is very much less than that of a train. Nevertheless, the disadvantages of inland waterways have proved serious in most countries of the world. In the first place, natural waterways—rivers—even when suitable for navigation rarely run in the direction in which it is most desirable they should run. Were the Missouri and Mississippi the sole avenue of egress from the wheat and maize lands of the central States, the damage done to the grain by the long journey through warmer and more humid climes to New Orleans would, alone, effectively have prevented the expansion of the export trade. Of the greatest rivers of Europe, the Volga enters into an inland sea, the Danube into an enclosed sea remote from the industrial centres of the continent. The rivers of Siberia and Northern Canada enter into a frozen, useless ocean. The majority of rivers need to be dredged or canalized before they are fit for navigation: the slower rivers suffer from innumerable tortuous meanders and shifting sandbanks. Canals are expensive to construct and expensive to maintain; an average reasonable speed of canal traffic of from three to ten miles per hour is often halved where there are many locks. It will be sufficient here, however, merely to indicate the relative importance of railways and canals in certain leading countries (from the *Statesman's Year Book*).

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[1] In this book we are considering mainly those countries of importance in international commerce. In nearly all such the old primitive means of transport have disappeared or are disappearing. We shall not, therefore, consider human carriers, camels, elephants, pack animals, bullock wagons, and numerous other means of transport. Though these ancient methods of transport are still important in such countries as India, China, and the tropical parts of Africa, the spread of the motor car in recent years has been phenomenal.

GOODS CARRIED IN 1929 (IN MILLIONS OF TONS)

Country	Rail mileage	Goods by rail	Goods by inland waterways	Waterways mileage
United Kingdom . .	20,419	330·0	14·4 [1]	4,673 [1]
United States . .	262,546	1,419·0	173·2 [2]	—
France	26,177	—	37·1 [3]	6,796 [2]
Germany	36,231	485·9	110·7	4,665
Canada	41,410	115·2	13·7	2,700
Australia	26,330	34·5	—	—

[1] Excluding Manchester Ship Canal.
[2] 1924 (*Commerce Year Book*). [3] 1925.

INLAND WATERWAYS

The above table illustrates the much greater importance of railways when compared with canals and rivers. Yet four of the countries in the above list are characterized by the *relative* importance of their inland waterways. The United States and Canada share the magnificent waterways afforded by the Great Lakes, whilst France and Germany have the best developed systems of canals and navigable rivers in the world.

North America.—In Canada several of the great northern rivers are navigable during the summer months but are little used. These include the Yukon from Whitehorse through Alaska to the ocean, the Mackenzie from the Great Slave Lake to the Arctic Ocean; the Saskatchewan from Edmonton to Lake Winnipeg; the Nelson and Albany for shorter distances. Despite the fact that they are closed by ice from December to May, it would be difficult to exaggerate the importance of the Great Lakes and St. Lawrence River system to Canada. Vessels from the lake ports reach the Atlantic *viâ* Montreal without breaking bulk. In 1932 over 22,000 vessels carrying 200,000 passengers, and 17,960,000 tons of freight passed through the Canadian Canals. The United States traffic is even more important. In 1932 the Great Lakes trade amounted to 98,000,000 tons, in addition to 10,400,000 tons of goods passing between the United States and Canada. The cargo tonnage passing through the Sault Ste. Marie Canals is three times that through the Panama Canal. The bulk of the traffic is iron ore and coal and grain. For many years schemes have been considered for connecting the Great Lakes with the Atlantic by means of a ship canal, so that ocean-going liners could pass through direct. It is probable that eventually the St. Lawrence will be canalized for this purpose.

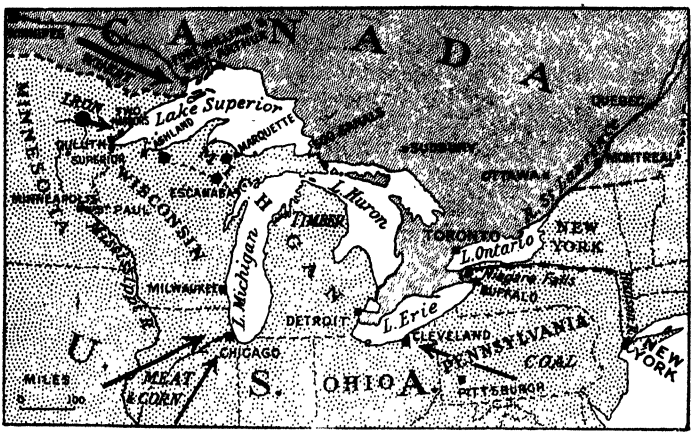
CANADA
Lake Superior
IRON
TWO HARBORS
DULUTH
SUPERIOR
ASHLAND
MARQUETTE
ESCANABA
MINNESOTA
MINNEAPOLIS
ST. PAUL
WISCONSIN
MISSISSIPPI R.
MILWAUKEE
L. Michigan
MICHIGAN
TIMBER
L. Huron
DETROIT
CHICAGO
MEAT & CORN
MILES
0 100
U. S. A.
OHIO
TORONTO
OTTAWA
MONTREAL
QUEBEC
St. Lawrence R.
L. Ontario
Niagara Falls
BUFFALO
L. Erie
CLEVELAND
NEW YORK
PENNSYLVANIA
COAL
PITTSBURGH
Hudson R.
NEW YORK

FIG. 189.—The inland waterways of eastern North America.
Round dots indicate principal occurrences of iron ore.

Another important waterway in the United States is the Mississippi and Warrior system—the Mississippi between St. Louis and New Orleans and the Warrior River between Birmingham and Mobile. **In 1929 cargo tonnage on the Mississippi was 1,398,800: on the Warrior 255,000.**

The remaining important system is the New York State Canals, carrying 4,074,000 tons of goods in 1933.

South America.—In South America there are two very important navigable river systems—that of the Amazon and its tributaries,

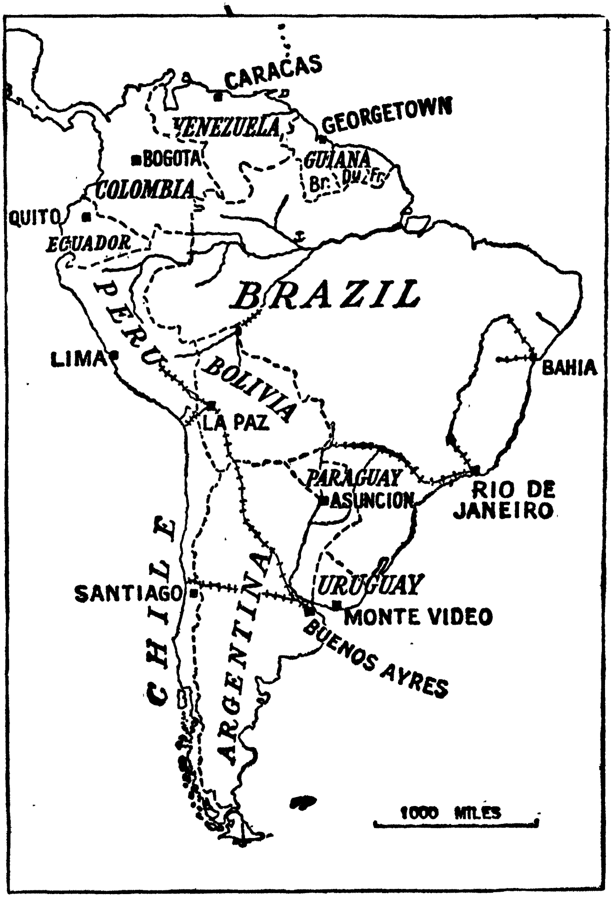
CARACAS
VENEZUELA
GEORGETOWN
BOGOTA
GUIANA
Br.
Du.
Fr.
COLOMBIA
QUITO
ECUADOR
BRAZIL
PERU
LIMA
BOLIVIA
BAHIA
LA PAZ
PARAGUAY
ASUNCION
RIO DE JANEIRO
CHILE
SANTIAGO
ARGENTINA
URUGUAY
MONTE VIDEO
BUENOS AYRES
1000 MILES

Fig. 190.—Map of South America showing navigable waterways and connecting railways.

The object of this map is not to show the complete railway systems of the continent, but to illustrate the way in which certain railways link up navigable rivers. A considerable section of the trans-Andine Railway was washed away in January 1934 and has not yet been restored.

and that of the Parana-Paraguay (Plate). The Amazon is navigable for 1,000 miles by ocean-going steamers as far as Manaos and by river steamers far into Peru. Many of the tributaries are also navigable, though the important Madeira is interrupted by rapids and falls near the Bolivian frontier. The rapids have been circumvented by a short railway.

The Paraguay (of which the estuarine portion is known as the Plate), is navigable through Argentina and Paraguay into Brazilian territory, its tributary the Parana far into Brazil.

Other navigable rivers in South America include the Cauca, Magdalena, Orinoco, Sao Francisco, Uruguay, and Negro, though some of them are interrupted at intervals by rapids.

Africa.—There are three river systems of first importance as navigable highways in Africa—the Nile, Niger, and Congo. These rivers are interrupted by rapids where they descend from the African plateau, and, generally speaking, have a long navigable course on the surface of the plateau and a shorter course near the mouth. In the case of the Nile, Niger, and Congo railways have been built to circumvent the unnavigable stretches. Study this carefully in Fig. 195. Other African rivers, notably the Zambesi, are navigable for shorter distances.

Australia.—Certain Australian rivers are navigable for short distances from their mouths, but only the Murray-Darling is really important. The Darling, more than the Murray, suffers from enormous variations in the volume of water. Sandbars obstruct the entrance to the river, and although extensive schemes for the canalization of the Murray have been approved and in part carried out, the real importance of the river is as a source of water for irrigation.

Asia.—Of the great rivers of Asia those of Siberia are of little use owing to their northward trend. Amongst those of China both the Yangtze and the Si-kiang are of first-class importance. The Yangtze is navigable by ocean-going vessels as far as Hankow. The Mekong is an important highway in French Indo-China, whilst the Irrawaddy remains the main artery of trade in Burma, being navigable by river steamers as far as Bhamo, 1,000 miles from the mouth. Of the Indian rivers the lower courses of the Ganges and Brahmaputra are still important, but the extensive use of the waters of the Upper Ganges and the tributaries of the Indus for irrigation has robbed these rivers of their former importance as highways. The Indian canals, too, are mainly for irrigation, and of those used for navigation the most important are the Calcutta and Eastern Canal, crossing the Ganges Delta, the Buckingham Canal running near the coast north and south of Madras, and the West Coast Canals.

Europe.—In Great Britain the very important Manchester Ship Canal is not generally regarded as a part of the inland water way system. Its function is to convert Manchester into a seaport, open in particular to ocean-going vessels engaged in the trans-Atlantic trade. Out of the remaining 4,673 miles of canal and navigable waterway in the British Isles, 3,641 miles are in England and Wales. Roughly one-third of the mileage is owned and controlled by the railways, but the total tonnage of goods carried on the railway canals in 1932 was only 1,324,000. The canals of Britain are, generally speaking, in a moribund condition : one of the most prosperous systems at the present time is the Aire and Calder Navigation system serving, in particular, the city of Leeds. The Grand Union Canal, from London to the Midlands, has been modernised.

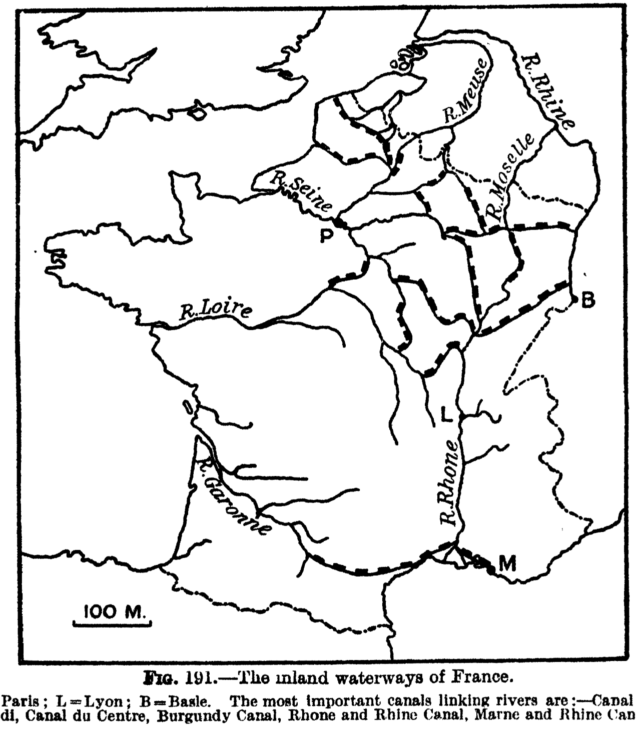

Fig. 191.—The inland waterways of France.

P=Paris ; L=Lyon ; B=Basle. The most important canals linking rivers are :—Canal du Midi, Canal du Centre, Burgundy Canal, Rhone and Rhine Canal, Marne and Rhine Canal.

On the continent of Europe, inland waterways are particularly important in France, Belgium, Holland, and Germany. Fig. 191 shows the way in which the principal rivers of France have all been connected by canals so that there is continuous communication by waterway from the Mediterranean to the Atlantic Ocean, to the English Channel and to the North Sea. The use of the canal systems in France is encouraged in certain ways by the French Government. The River Rhine is a highway of premier importance to Switzerland, France, and especially to Germany Its disadvantage to the countries mentioned lies in the fact that it flows through Dutch territory before reaching the open sea and thereby confers immense benefits on the trade of Rotterdam. The Germans have attempted to attract trade from the Rhine, particularly from the Ruhr industrial-region, to a German seaport by constructing the Ems-Dortmund Canal, but the attempt has only been partly successful. The Rhine is navigable for large-scale barge traffic as far as Strasbourg, and, at certain seasons of the year, by barges of limited draught to the Swiss frontier. It will be noticed from Fig. 192 that the German rivers flow, in general, from south-east to north-west. The great aim of canal construction in Germany has been the construction of east to west links. How far this has actually been done can be seen from the diagram.

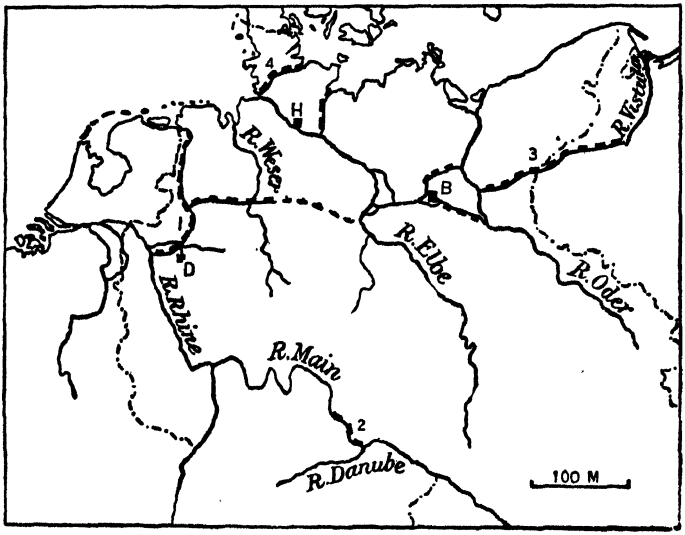

Fig. 192.—The inland waterways of Germany.

B = Berlin; H = Hamburg; D = Dortmund; 1 = Ems-Dortmund Canal; 2 = Ludwig Canal; 3 = Oder-Vistula Canal; 4 = Kiel Ship Canal.
The great "Mittelland" Canal, connecting the Weser and Elbe, was completed in 1938.

Outside of France and Germany, the River Danube forms the most important waterway of Europe. It is navigable for 1,500 miles from Ulm downwards and below Turnu Severin by sea-going vessels. Below Budapest, however, the banks are marshy and afford few sites for towns; for two months in winter fixed or floating ice is a serious obstruction, and the river flows away from the populous centres of Europe. Even in the pre-war prosperous days of Vienna, the total tonnage there was less than a tenth of that of the Seine at Paris. Although the Danube is joined by a canal with the Main and thus with the Rhine (Ludwig's Canal), there is comparatively little traffic by this route.

Certain isolated but important canals in Europe should be noted, especially the Kiel Canal, facilitating the passage of steamers from the North Sea to the Baltic Sea. The canal across the Isthmus of Corinth in Greece, on the other hand, has not been very successful. The important waterways, by canal and lake, from the North Sea to Stockholm should be noted.

RAILWAYS

The gauge of a railway (the distance between the two metals) is the determining factor in the alignment, building, and running.

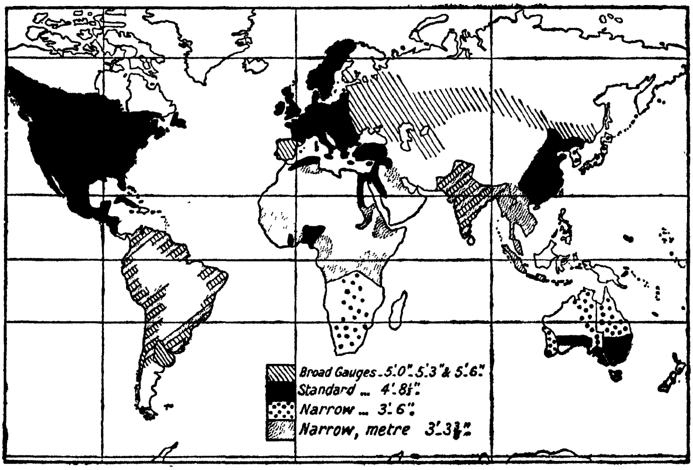

FIG. 193.—Map of the World showing railway gauges (generalised).

About half a dozen different gauges are in common use in different parts of the world.

(*a*) Broad gauges (5 ft. 0 in., 5 ft. 3 in. and 5 ft. 6 in.). Broad-gauge lines cannot be laid round sharp curves, and are most suitable, therefore, for comparatively level countries. The speeds, and in general the loads, possible on a standard gauge cannot be increased on a broad gauge, and it is difficult to find any important features in which a broad gauge is to be preferred to the standard gauge.

(*b*) Standard gauge (4 ft. 8½ ins.). The standard gauge is the most widely used of all gauges, being found over the whole of North America and the whole of Europe excepting Spain and Russia. The world's fastest trains and heaviest trains are run on standard gauge. Scheduled times up to 60 miles per hour are possible.

(*c*) Narrow gauges (3 ft. 6 ins.; 3 ft. 3⅜ ins. or 1 metre; also smaller gauges). Narrow gauges are, in certain circumstances, to be preferred to the standard gauge. The lines can be laid round comparatively sharp curves, making the narrow gauges more suited to hilly country; the cost of construction is much less than in the case of the standard gauge. On the other hand, the trains are slower and lighter. Scheduled speeds rarely exceed 35 miles per hour. The very efficient South African Railways are on the 3-ft. 6-in. gauge.

Fig. 193 shows the distribution of the principal gauges.

TRANSCONTINENTAL RAILWAYS

It is impossible to do more here than to notice some of the more important of the great transcontinental railways.

North America.—In Canada the great barrier formed by the Rocky Mountains has been surmounted by railways at two points. The Canadian Pacific Railway uses the Kicking Horse Pass, the Canadian National Railway uses the Yellowhead Pass. There are three main transcontinental lines:

(1) C.P.R. from Vancouver up the valleys of the Fraser and Thomson Rivers, across the Rockies and the Prairies to Winnipeg, the Great Lakes at Fort William and Port Arthur, then to Ottawa, Montreal, Quebec, and Halifax. An important branch runs to Toronto.

(2) C.N.R., occupying on the whole a less favourable position further north, from Vancouver up the Fraser and North Thomson valleys, across the Rockies by the Yellowhead Pass, *viâ* Edmonton to Winnipeg and thence by a northern route to Quebec.

(3) C.N.R. from Prince Rupert—still a very small town—by the Yellowhead Pass to Edmonton, thence north of the other C.N.R. line to Winnipeg.

In the United States there are four main transcontinental lines, as shown in Fig. 194. These lines have assumed an exceptional importance in the States because of the development of the regions at their western and eastern ends. California, the great fruit orchard of the United States, and now the leading oil state, until the opening of the Panama Canal relied entirely on railway communication for contact with the older east. The rivers assist but little in the east-west communication. Artificial waterways across the Rockies are out of the question; there was no alternative sea route. Hence the whole burden of communication fell on the railways, and despite the Panama Canal much of it still remains

The long-distance freight trains, with their 80- or 100-ton trucks characteristic of the North American continent, are virtually unknown elsewhere. The great bulk of Canada's wheat and the United States wheat and corn are far from a waterway and are "bulk-handled" by the railways.

In both Canada and the United States the railways acted as pioneers in making possible the opening up of vast tracts of country. In this respect they form a marked contrast with other countries, where the railways have followed tardily upon the heels of the early settlers. Even in the opening up of Australia, the railways grew out as concerns mainly of parochial interest from the early centres.

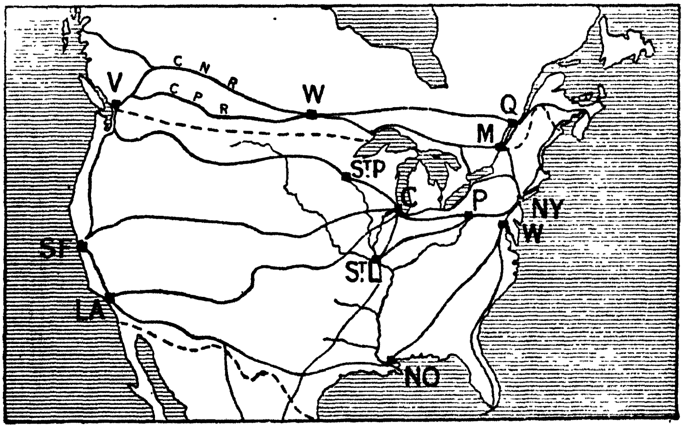

FIG. 194.—Railways of North America.

South America.—South America boasts an important network of railways in the great wheat and cattle lands of Argentina, and another in South-Eastern Brazil. A transcontinental line joins Valparaiso with Buenos Aires, but the great height at which it crosses the Andes, the snowdrifts in winter, and the break of gauge continue to minimize its importance. On the west coast of South America a number of short but important lines connect the leading ports with the chief towns of their hinterlands. These railways have made possible the still slight development of the mineral richness of the high Andean plateaux.

Africa.—The present position of African railways is seen from Fig. 195. There is a well-developed system of 3-ft. 6-in. gauge lines in South Africa, stretching from Cape Town to the Belgian Congo. Northwards of that region rail transport supplements river and lake transport. Notice the short lengths of line which circumvent rapids on the Congo, join the Congo with the great lakes and the lakes with the east coast. In order to complete the through rail and steamer communication between Cape Town and Cairo only one short length of line is still needed—from Uganda to Rejaf, the head of navigation on the Nile. Railway construction is being pushed on actively in the Congo, Nigeria, and elsewhere. There is an important network in the Mediterranean states of North Africa. The great need of the future in Africa will be the building of one or more great trunk lines—such as from Tangier to Cape Town—to link up the existing isolated lines.

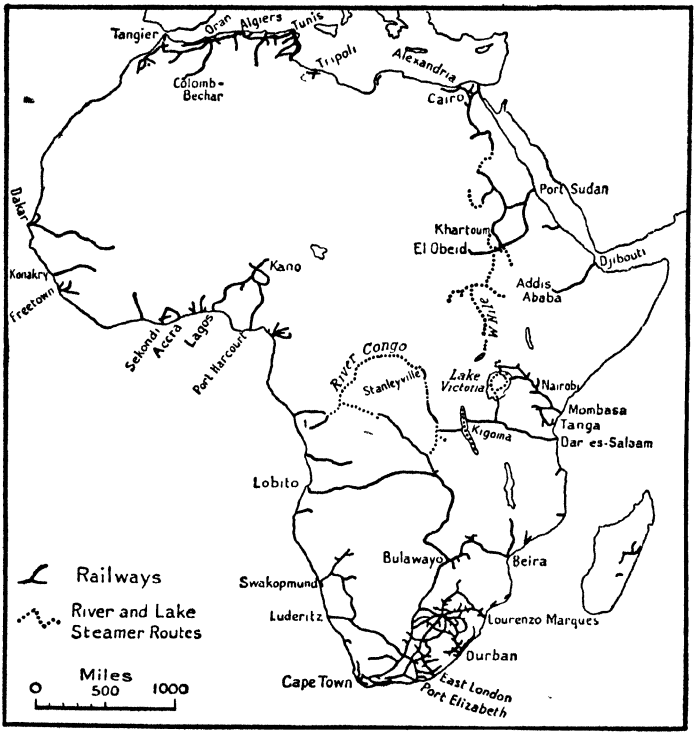
Tangier
Oran
Algiers
Tunis
Tripoli
Alexandria
Colomb-Bechar
Cairo
Port Sudan
Dakar
Khartoum
El Obeid
Djibouti
Konakry
Kano
Addis Ababa
Freetown
Nile
Sekondi
Accra
Lagos
Port Harcourt
Congo
River
Stanleyville
Lake Victoria
Nairobi
Mombasa
Tanga
Kigoma
Dar es-Salaam
Lobito
Bulawayo
Beira
Railways
Swakopmund
River and Lake Steamer Routes
Luderitz
Lourenzo Marques
Durban
Miles
0
500
1000
Cape Town
East London
Port Elizabeth

FIG. 195.—Railways of Africa.

The object of this map is to show, in the first place, the numerous isolated networks or short lengths of line scattered over Africa, and in the second place the way in which river and rail supplement one other.

Australia.—The Australian railway system has grown up gradually around a number of independent points—the State Capitals. The State systems have long since reached the borders of the States, and the difficulty now lies in the confusion of gauges. Queensland and Western Australia use the 3-ft. 6-in. gauge; New South Wales the standard gauge (4 ft. 8½ ins.); and Victoria the broad gauge. The great transcontinental line from Kalgoorlie in Western Australia to Port Augusta in South Australia, owned and run by the Commonwealth Government, is standard gauge, and the general policy is towards unification of all railways to the standard gauge. At present eight changes of coach are required in the journey from Perth to Brisbane.

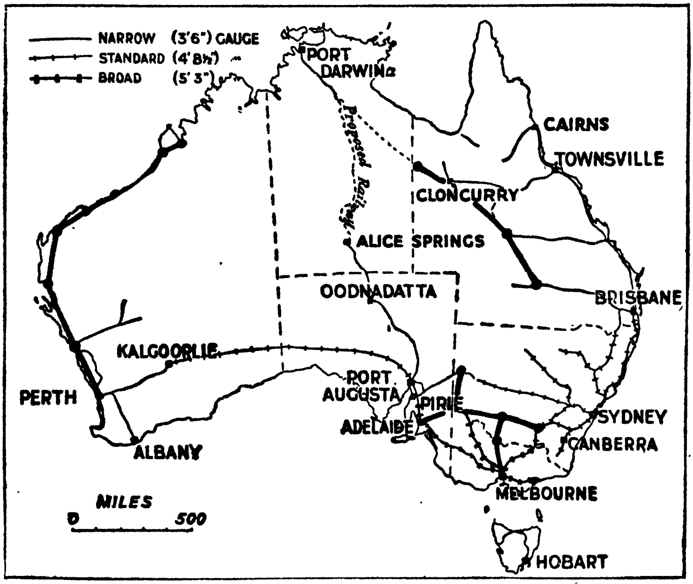
NARROW (3'6") GAUGE
STANDARD (4'8½")
BROAD (5'3")
PORT DARWIN
Proposed Railway
CAIRNS
TOWNSVILLE
CLONCURRY
ALICE SPRINGS
OODNADATTA
BRISBANE
KALGOORLIE
PORT AUGUSTA
PIRIE
PERTH
ADELAIDE
ALBANY
SYDNEY
CANBERRA
MELBOURNE
MILES
0
500
HOBART

FIG. 196.—Railways of Australia, showing the various gauges.

The heavy black lines are the aerial routes, and show how the aeroplane has been used in Australia to link up towns not yet served by rail. There are now (1939) subsidized lines also from Perth to Adelaide, Perth to Wyndham, and Brisbane to Cloncurry and Normanton. Regular aerial communication with Britain is being established.

New Zealand's railways also grew up from isolated centres, but the need for adopting a common gauge was realized at an early stage and all lines are on the 3-ft. 6-in. gauge.

Asia.—Only two Asiatic countries are adequately provided with railways—India and Japan. India's important network of 43,000 miles consists of 21,000 miles of broad gauge (5 ft. 6 ins.) and the remainder mainly of metre gauge. At present there is no connection by rail between India and any of the surrounding countries. Japan's efficient system is on the 3-ft. 6-in. gauge. The few railways at present existing in China are mainly the result of Japanese, British, and Russian enterprise. The recent economic progress of Malaya is reflected in the development of the well-organized metre-gauge railways, now joined up with those of Siam. French enterprise is seen in the railways of Indo-China, penetrating northwards into China, and the Dutch have built a considerable system in Java. In the Near East, Baghdad has been linked with Basra by a metre gauge line, but work on the main line from Europe to Baghdad has long been suspended, although only about 100 miles remain to be completed. Palestine and Syria, including Damascus, are now linked up with the Egyptian system.

The Trans-Siberian railway is too well known to require more than passing mention. In the years preceding the war railways did much to open up the rich steppe lands of Siberia, but there are still vast tracts in Asia which need pioneer railways—as did the prairies of Canada—before they can be adequately developed.

Europe.—There are a number of salient points to be noted with regard to the very complicated network of railways in Europe. In the first place, all important European railways are on the standard gauge except in the Iberian Peninsula and in Russia. Both these countries have broader gauges. The main junctions with these broad-gauge lines are at Riga and Warsaw. In the second place, certain mountain chains in Europe have acted as important barriers. No railway at present crosses the Pyrenees, the links between France and Spain are along the coasts at the eastern end and the western end. The Alps have been gradually conquered by a series of stupendous tunnels—the Simplon, Mont Cenis, and St. Gotthard in particular. For hundreds of miles no railway crosses the Carpathians. In Italy the Apennines have proved a serious obstacle.

The more important European lines will be considered in Part II.

EXERCISES

1. Keep the table showing comparative importance of inland waterway and railway transport up to date from the *Statesman's Year Book.*

2. Draw a sketch-map of North America, shading those parts accessible only by railway (*i.e.* more than 100 miles from a navigable waterway). Draw a corresponding map for Europe. What inferences can you make?

3. Draw diagrams to show for the leading countries of the world, (*a*) length of railways, (*b*) length of railway per head of population (figures from *Statesman's Year Book*).

4. Draw a map of Asia, indicating what main railways you consider necessary. Give reasons for each one suggested.

5. Carry out the last exercise for any part of the world in which you are particularly interested.

EXAMINATION QUESTIONS

1. Compare, and contrast, railway development and railway communications in North America and Australia. (*Univ. London Inter. B. Com.*, 1927.)

2. Describe, with the aid of sketch-maps, the main north and south trade routes in Europe. (*Asst. Insp. Taxes, G.B.*, 1927.)

3. With special reference to the present position and possible future developments, indicate the leading geographical facts of importance in the motor-car industry.

4. Consider generally, with examples, the value of inland waterways as a means of transport. (*Univ. London Inter. B.Sc. (Econ.)*, 1925.)

5. Contrast the conditions of inland transport by water in England and in Germany. (*Univ. London Inter. B. Com.*, 1920.)

6. Illustrate, by examples taken from different parts of the world, the way in which the following act as checks to easy land communication: (1) deserts, (2) fiord coasts, (3) lofty mountain ranges, (4) plateaux with a steep mountain edge. (*Univ. London Inter. B. Com.*, 1924.)

7. Discuss the economic importance of the rivers of the United States. (*Univ. London Inter. B. Com.*, 1928.)

8. What improvements in communications do you consider necessary in *either* Africa *or* the Far East? (*Univ. London Inter. B. Com.*, 1928.)

9. Compare the Union of South Africa with eastern Australia in respect of (i) ease, (ii) difficulty of inland commercial transport. (*Univ. London Inter. B. Com.*, 1930.)

CHAPTER XIV

OCEAN TRANSPORT

We have now dealt with the leading commodities which enter into international commerce and the circumstances of their production, and have considered the means whereby they are transported by land to the great ports. There remains for consideration the means whereby these commodities are carried from country to country, bridging barriers of sea and ocean.

THE WORLD'S MERCHANT MARINE

Tonnage.—There are several units of measurement used in reference to ships which it is desirable should be clearly understood.

(*a*) " Cargo Tonnage " refers nominally to the actual weight of cargo carried, expressed in long tons (2,240 lbs.) or short tons (2,000 lbs.). Actually, however, it is usually calculated by reckoning 40 cubic feet of cargo equivalent to one ton.

(*b*) " Gross Tonnage " refers to space measurement, not to actual weight, 100 cubic feet being reckoned as one ton. Gross tonnage is the capacity of the entire space within the frame of the vessel and the deck, together with closed-in space above deck.

(*c*) " Net or Registered Tonnage " refers also to space measurement and is equivalent to gross tonnage less the space occupied by engines and gear, crew's quarters and officers' quarters. It represents, approximately, the space available for cargo and passengers.

(*d*) " Displacement tonnage " refers to the weight of water displaced by the vessel when fully laden.

World's Ships.—According to Lloyd's Register, the gross tonnage of steam and motor vessels of the Merchant Service on June 30, 1933, was 66,628,000, and of sailing vessels 1,292,000, making a total of 67,920,000 tons. Fig. 197 shows the variation in world tonnage in recent years.[1]

The Seafaring Nations.—Fig. 198 shows the tonnage owned by the leading nations of the world. Two points stand out very clearly. One is the predominant position of the United Kingdom and the United States, which together own about 55 per cent. of the world's tonnage. The other is the rapid rise in importance of the United States fleet since 1914. Of merchant navies of second rank Japan leads, but the fleets of Germany, France, Italy, Norway, and the Netherlands are of roughly equal size, and only a little smaller than that of Japan. Of roughly the same size is the combined fleet of the British Dominions.

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[1] This graph may be kept up to date from the tables in the *Statesman's Year Book*, or direct from Lloyd's Register. Particulars given in the *Commerce Year Book* (*U.S. Dept. of Commerce*) exclude shipping on the Great Lakes, and the totals are therefore smaller.

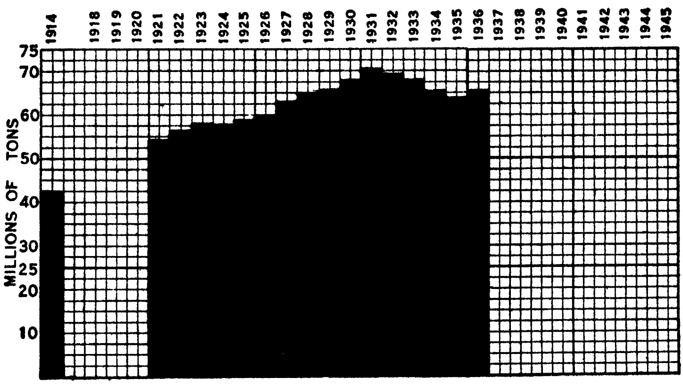

FIG. 197.—World shipping.

From the *Commerce Year Book.* Excluding tonnage on the Great Lakes, and hence smaller by 2 or 3 million tons than the totals given in the *Statesman's Year Book.* (Gross tonnage of steam and motor vessels over 100 tons.)

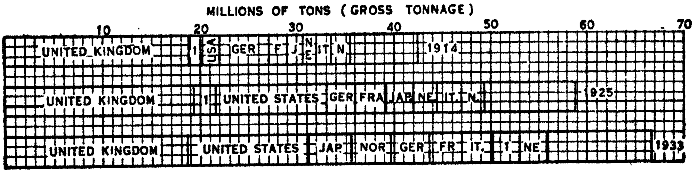

FIG. 198.—Merchant shipping—tonnage owned by leading countries.

1 = British Dominions; Ger. = Germany; F. = France; J. = Japan; Ne. = Netherlands; It. = Italy; N. = Norway.

Motive Power.[1]—There has been a marked increase in recent years of oil-burning vessels and also, more recently, of motor vessels. In 1914 less than 5 per cent. of the world's ships used oil fuel; in 1929 the proportion was 45 per cent. and still increasing.

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[1] To be kept up to date from the *Commerce Year Book.*

This 45 per cent. includes 36 per cent. oil burners and rather under 9 per cent. motor ships. Since 1914 the market for coal as fuel has decreased rather than increased, but the world's "tanker" fleet—used largely in transporting oil for ships' fuel—represented over 13 per cent. of the world's total tonnage in 1933. Sailing vessels are still numerous, though the total tonnage is but small—a little under 2 per cent. of the whole in 1933. Sailing vessels are used mainly for short journeys, and special types of cargo—such, for example, as the transport of wood from Norway and Sweden to England.

Types of Vessel.[1]—"Excluding shipping used exclusively or chiefly for internal and coasting traffic, the world's transoceanic and interoceanic shipping services are almost wholly carried on by 5,575 ocean steamers each of 4,000 gross tons or over, and aggregating 22,210,000 net tons." 3,375 liners of 14,500,000 net tons and 700 tankers of 3,000,000 net tons are owned and operated by less than 150 companies or corporations. The 1,500 general trading steamers or "tramps," owned by small companies and individuals, aggregate less than 5,000,000 net tons. Taking into consideration speed, over 80 per cent. of ocean traffic is handled by liners using regular routes, and the bulk in vessels of over 6,000 gross tons. As an indication of size it may be noted that the world's largest steamer, the *Normandie*, is 79,000 gross tons, but the majority of trans-Atlantic liners are between 10,000 and 25,000 tons. Those on other routes are, on an average, smaller.

OCEAN TRADE ROUTES

The predominating importance of ocean liners in the transoceanic carrying trade has already been indicated, and it follows that the bulk of the world's trade passes along well-marked ocean highways. These highways not only run from one well-equipped terminal port to another, but are provided with coaling, oiling, and refitting stations en route. The routes are well surveyed, the dangerous spots marked by lighthouses and lightships, and the special peculiarities of each portion accurately known. An additional degree of safety is afforded by the numerous vessels using the same route and able, therefore, to render help to a vessel in distress. Other things being equal, ocean routes tend to follow the shortest line between two ports, which is actually the arc of a great circle passing through the two points. Such "great circle" routes appear as curved lines on the map. An interesting exercise is to take a globe and to measure the distance between such a pair of ports as Yokohama (Japan) and Vancouver (Canada) (*a*) by the great circle; (*b*) by following along a line of latitude between the two.

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[1] From the *Commerce Year Book*, 1925.

Fig. 199 shows the principal ocean trade routes of the world. The width of the black lines is apportioned roughly to the importance of the route.[1]

North Atlantic Routes.—These routes lie mainly between the North Atlantic ports of North America, from Baltimore and Newport News in the south to Montreal and Quebec in the north, on the one hand, and the ports of the British Isles and the European coast from Cherbourg to Hamburg on the other. In Canada, the leading ports are Montreal and Quebec. These ports are, however, closed by ice from December to May, when Halifax and St. John become the "winter ports" of Canada. In the United States the four great ports are New York, Boston, Philadelphia, and Baltimore. About 61 per cent. (1930–32) of the United States imports are received through these ports, and over 21 per cent. of the exports pass through them. On the European side the leading ports are Liverpool, Southampton, Glasgow, and London in the British Isles; Cherbourg, Le Havre, Rotterdam, and Hamburg on the Continent. The trade in the eastward direction is very largely in grain and flour, meat and dairy produce. In the opposite direction manufactured goods predominate.

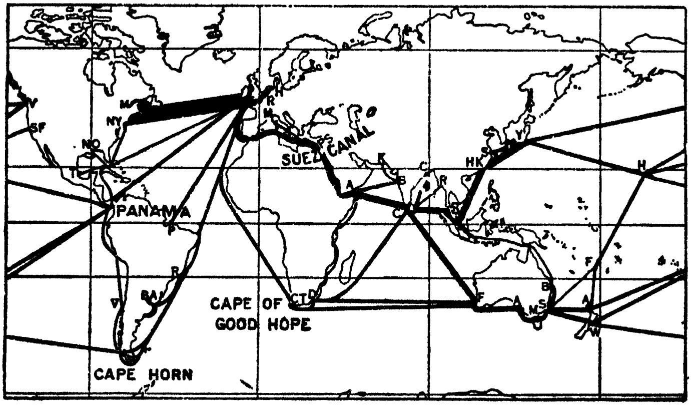

FIG 199.—Ocean trade routes.

All ports marked by letters should be identified.

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[1] The traffic of the principal ocean trade routes is carefully analysed in Professor A. J. Sargent's *Sea Ways of the Empire*, which, though dealing with the subject from the point of view of the British Empire, covers most of the important ocean routes. The essential figures for assessing the relative importance of routes from the United States are given annually in the *Commerce Year Book*.

Subsidiary to the routes mentioned are those from the Gulf ports—Galveston and New Orleans—and South Atlantic ports (notably Charleston) of the United States to the coast of Europe. The important cargo is raw cotton. The Gulf ports of the United States handle about 20 per cent. of her total foreign trade. Then there are the routes from North America to the Spanish, Portuguese, and Mediterranean ports (especially Marseilles).

The Panama and West Indian Routes.—These routes cross the Atlantic from Central America, the Panama Canal, and the West Indian Islands to Europe. Of the traffic through the Panama Canal a very large proportion—over half—is American, but a very large percentage of this can be grouped as "domestic" traffic from the west coast of the United States to the east coast or *vice versâ*. Out of a cargo tonnage of 30,000,000 passing through the Canal in 1930 over 11,000,000 tons represented trade between the east and west coast of the United States. Together with the routes now being considered may be mentioned the large traffic between Mexico, Cuba, and the United States as well as that between the West Indies and Canada. Of the routes passing through the Panama Canal that down the west coast of South America to Ecuador, Peru, and Chile is very important, and the Peru—Chilean—European trade has benefited greatly from the Canal.

South Atlantic Routes.—These routes connect Argentina, Uruguay, and Brazil in South America with North-Western Europe. The leading South American ports are Buenos Aires in Argentina; Montevideo in Uruguay; Santos, Rio de Janeiro, Bahia and Pernambuco in Brazil. Hamburg, London, Liverpool, Havre, Marseilles, and Genoa are the principal terminal ports in Europe; Spanish and Portuguese ports are called at en route, whilst most liners use the Canary Islands or Madeira as coaling stations. The eastward-bound cargoes are wheat, meat, wool, hides, and skins from Argentina and Uruguay; coffee from Brazil. Iron and steel goods and textiles are the leading cargoes in the opposite direction. With these routes may be mentioned the ones from England to the Amazon and to the Guianas.

The Cape Routes.—Under this title may be included those routes which pass southwards from Europe and round the Cape of Good Hope. In passing, it should be noted that West Africa is served by local lines from Europe. The South African liners run from Southampton to Cape Town, calling as a rule only at the Canaries or Madeira. Durban may be regarded as the terminal port of the Europe-South Africa service; ports further north than Durban on the East Coast are reached *viâ* Suez. The route from Europe to Australia *viâ* the Cape remains an important one, and is used when time is less important than the saving of Suez Canal dues.

The Suez Routes.—Like the Panama, the Suez Canal forms the converging point for numerous lines. From the west there is a continuous stream of traffic from Hamburg, London, and Liverpool through the Straits of Gibraltar. Most liners call at Marseilles, and several important lines start from there. Other lines from Genoa and Trieste converge on Port Said, at the entrance to the Suez Canal. Passing through the Canal and the length of the Red Sea, the stream of traffic emerges into the Indian Ocean to divide into three branches. One goes east-north-eastwards *viâ* Aden to Bombay and Karachi, another runs south to serve the east coast of Africa, but the main stream crosses direct to Colombo, Ceylon. Here again the route forks, one branch going to Madras and Calcutta; a second to Rangoon; a third and very important one to Penang, Singapore, Hongkong, and China; a fourth to Australia (Fremantle, Adelaide, Melbourne, Sydney, and Brisbane). Obviously very varied cargoes pass through the Suez Canal, but as a general rule foodstuffs and raw materials predominate from the East (Australia, Far East, and India) and manufactured goods from the West. The importance of the mail routes through the Suez should be noted:

(1) London—Dover—Calais—Marseilles—Port Said—Aden—Bombay (14 days).

(2) London—Dover—Calais—Marseilles—Port Said—Colombo—Straits—China (28 days).

(3) London—Dover—Calais—Marseilles—Port Said—Colombo—Australia (30 days).

Despite the diversity of traffic through the Suez, it is interesting to note that in recent years the cargo-tonnage passing through the Suez Canal has been less than through the Panama Canal, but this is to be largely accounted for by the heavy domestic traffic of the United States using the Panama.

Trans-Pacific Routes.—Trans-Pacific routes fall into four main groups:

(*a*) Manila (Philippine Islands), Hongkong, and Shanghai, *viâ* Nagasaki, Kobe, and Yokohama, in Japan, direct to Vancouver and Seattle.

(*b*) From the same Asiatic ports *viâ* Honolulu to San Francisco, Los Angeles, and the Panama.

(*c*) From Melbourne and Sydney in Australia *viâ* Auckland or Wellington in New Zealand to the Panama; continuing across the Atlantic to Europe.

(*d*) From Sydney or Auckland *viâ* Fiji or Samoa and Honolulu to San Francisco or Vancouver.

The Cape Horn route is now relatively unimportant.

PORTS

It is necessary in the first place to separate the total trade of any port into two divisions:

(*a*) Entrepôt or transit trade.
(*b*) What may be called "domestic" or home trade.

The trade of some ports belongs almost entirely to the first category. Port Said, Aden, and to a considerable extent Singapore, may be quoted as examples. The trade of other ports belongs wholly to the second category, and between the two extremes there is every gradation.

Entrepôt Ports.—The importance of an entrepôt port depends mainly on its position in relation to the great trade routes of the world. The exact position may have been determined originally by such favourable local conditions as the possession of a good natural harbour, in other cases strategic or military reasons have been the primary consideration. Generally speaking, an entrepôt port is also a fueling station and has also facilities for ship repairs. An excellent example of an entrepôt port is afforded by Port Said. at the northern entrance to the Suez Canal. All the routes from the West—from America, the British Isles, North-Western Europe, and the Mediterranean ports—converge on Port Said before passing through the Suez. Although all routes to the East pass down the Red Sea, they fork on emerging from that sea, and Port Said is the obvious junction. At the same time Port Said is not the natural outlet of the Nile Valley—Alexandria performs that function—and only handles a limited amount of Egypt's export trade.

"Domestic" Ports.—The importance of the majority of ports is decided by entirely different factors. In the first place the port must be so situated as to form the natural outlet for, and the natural entrance to a large and populous hinterland. The word "hinterland" (or hinderland) is a convenient term designating the area served by a port. A port backed by high mountains through which communication is difficult or impossible has a small hinterland; a port backed by a huge desert has a large but unproductive and thinly populated hinterland; indeed, its hinterland may be regarded as embracing solely the populous strip near the port itself (*e.g.* Aden). Facility of communication with the hinterland is often more important than a natural harbour, but given equal ease of communication with the interior the actual site of the port is usually determined by the existence of a natural harbour. Thus Bombay commands two important gaps through the Western Ghats into the rich cotton-growing interior; it has a magnificent natural harbour, Hence Bombay stands without a rival on the west coast of India. Many present-day ports were founded when only small sailing ships had to be considered. With the advent of large modern steamers they have either fallen into disuse, or have constructed harbour works, quays, wharfage, etc. Geographers are apt to forget or ignore the importance of what may be called geographical momentum on the one hand or geographical inertia on the other. Comparatively small natural advantages may, originally, have determined the position of the port; its growth is due to a small early momentum, snowball fashion. The natural advantages of London, far from any coalfield, a considerable distance up the river, are small compared with the huge importance of the port

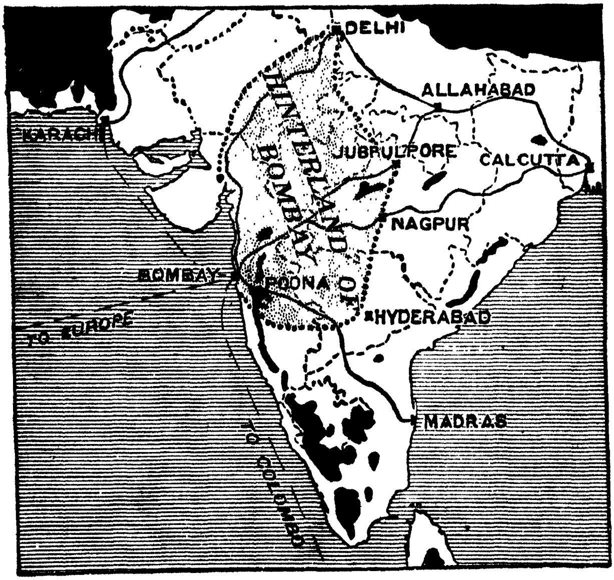

FIG. 200.—Ports and their hinterlands—the hinterland of Bombay.

Land over 2,500 feet, black. Notice the railways from Bombay passing through gaps in the Western Ghats.

Geographers should admit that the *present* size and importance of many of the leading ports of the world are the result of economic and political factors. Southampton has the advantage of high double tides, but railway enterprise has made it what it is to-day. Where no natural harbour exists, a fertile and prosperous hinterland will warrant the construction of an artificial harbour. Thus Montevideo is now one of the finest harbours in South America. On the other hand, some leading ports have comparatively poor natural harbours—Calcutta, many miles up the narrow and tortuous Hooghly, is an example. All modern ports must have deep water approaches, whether natural or dredged; a depth of 30 feet alongside the wharves at low tide will accommodate most modern liners. There are still many ports where the steamers cannot come alongside and goods must be loaded into lighters.

As examples of ports with a considerable entrepôt as well as a domestic trade, Colombo and London are particularly suitable for detailed study.

Before terminating this chapter we may note an inconspicuous but fundamental difference between the steamship companies—whether they be Government-aided concerns or not—of the United States and Japan on the one hand and of Great Britain, France, and Holland on the other. The former are essentially transport companies. The latter are not only transport companies, but they help also to maintain contact and communication between the integral parts of widely scattered empires. Thus the route of the N.Y.K. (Japanese) lines from Japan to Europe can be dictated by the requirements of commerce alone. Contrast with this the P. and O. (British) route from Europe to the Far East—London, Gibraltar (Br.), Marseilles (for mails despatched overland through France from London), Port Said, Aden (Br.), Colombo (Br.), Penang (Br.), Singapore (Br.), Hongkong (Br.), Shanghai (British Settlement), Japan. Compare with this the Messageries Maritimes (French) route—Marseilles, Port Said, Jibouti (Fr.), Colombo, Penang, Singapore, Saigon (Fr.), Haiphong (Fr.), Hongkong, Shanghai (French Settlement), Japan. Yet another example is afforded by the Nederland Royal Mail Line from Rotterdam (Ned.), Southampton, Algiers, Genoa, Port Said, Colombo, Sabang (Ned.), Belawan (Ned.), Singapore, Batavia (Ned.), Samarang (Ned.), and Surabaya (Ned.).

EXERCISES

1. Bring Figs. 197 and 198 up to date by reference to Lloyd's Register or the *Commerce Year Book* or the *Statesman's Year Book*.

2. All shipping routes mentioned should be carefully followed on an atlas, and the leading ports in connection with each route noted. Draw maps of each of the oceans, showing routes and ports in greater detail than on Fig. 199. From what you have learnt of the production and trade in the leading commodities, suggest important cargoes for each route.

3. Draw a diagram to show conveyance of routes in the Panama Canal.

4. Draw diagrams to illustrate the importance of the position of the following ports: New Orleans, Vancouver, Honolulu, Rotterdam, Liverpool.

EXAMINATION QUESTIONS

1. What are the essential differences between the services rendered by ocean liners and tramp steamers? (*Prov. Alberta Matric.*, 1927.)

2. Discuss the relative importance of the Suez and Panama Canals. (*Univ. Bristol Inter.*, 1925.)

3. "The Panama Canal has and always will have a greater importance for North America than for South America." Examine the truth of this statement (*Univ. Bristol Inter.*, 1924.)

4. A tramp steamer makes voyages between the following ports: New Orleans, Havre, Cardiff, Buenos Aires, London, Barry, Dakar, Marseilles. What were its probable cargoes between consecutive ports? (*Univ. Sheffield Inter. Hons.*, 1927.)

5. Discuss the North Atlantic Trade Route under the following headings:

(*a*) Reason for the route being a "trunk" route.
(*b*) Obstacles to navigation.
(*c*) Sources of fuel.
(*d*) Nature of traffic. (*Prov. Alberta, 3rd Year Matric.*, 1926.)

6. Indicate on an outline map of the world the important ports, steamship routes and railway lines. (*Univ. Toronto, Sessional*, 1926.)

7. Show the general character of imports and exports from the various ports (*Univ. Toronto, Sessional*, 1926.)

8. In what respects have the requirements for a commercial seaport changed with the application of mechanical power to transport? (*Univ. Oxford Cert.*, 1927.)

9. What are the essentials for maintaining a large entrepôt trade? Discuss the effects of the opening of the Panama Canal on the entrepôt trade of London. (*Univ. Bristol Inter.*, 1927.)

10. Write a reasoned account of the geographical factors concerned in the rise, growth, and decay of seaports. (*Univ. Oxford Cert.*, 1926.)

11. What do you understand by the "hinderland" of a seaport? Sketch and explain the extent of the hinderlands in the cases of Hull, Hamburg, and Liverpool. What other ports in the same hinderlands are competing with these and what geographical factors are influencing such competition? (*Univ. Bristol Inter.*, 1926.)

12. "The importance of a port depends mainly upon the extent and the productiveness of its hinterland." Discuss this statement with special reference to Calcutta, Buenos Aires, London, and Singapore. (*Univ. London, Inter. B. Com.*, 1927.)

13. Describe a journey from Yokohama to London, using these headings—

(1) What cargo is put into the steamer at Yokohama—where each thing comes from—where it is going to.

(2) Stopping places on the way—number of days between each port, and total number of days spent on the journey.

(3) What new cargo is taken on at each stopping place.

(4) The journey takes place in December. What differences would the passengers notice if they travelled in August?

14. A traveller from Adelaide wants to go to England. By what different routes can he make that journey? Which route should he choose if he wants to reach England in the shortest time?

15. Has the North or the South Atlantic the more suitable positions for ports? Why? Is this the only reason why one ocean has so many more ports than the other?

16. What do you understand by the hinterland of a port? Show by reference to ports in North America or Europe how the richness and size of the hinterland influence the importance of the port.

17. What conditions generally determine a good harbour? How far do these conditions hold good in the case of New York, Bombay, Madras, and Dunedin?

18. "He that rules the sea rules the commerce of the world." Discuss the truth or otherwise of this statement with reference to England and the United States.

19. Describe *either* (*a*) a railway journey from Paris to Rome, *or* (*b*) a coasting voyage from Singapore to Yokohama. (*Punjab Matric.*, 1911.)

20. Plan a tour round the world, having as its main object a study of world trade.

21. Write a brief account of the part played in the present century by the British merchant fleet in the carrying trade of the world. (*Asst. Insp. Taxes, G.B.*, 1927.)

22. Describe the various causes of the deviation of trade routes from the shortest lines, illustrating your answer by diagrams *either* of the routes round and through the Alps *or* of the routes between Western Europe and India. (*Univ. London Inter. B.Sc.* (*Econ.*), 1924.)

23. Compare and contrast, on broad lines, the three southern continents in the relation they bear to the great industrial regions of the Northern Hemisphere. (*Univ. London Inter. B.Sc.* (*Econ.*), 1923.)

24. Illustrate, by a description of one example in each case, the factors which determine the ocean routes taken by (1) steamers and (2) sailing ships. (*Univ. London Inter. B. Com.*, 1924.)

25. Compare the various great circle routes in the Pacific Ocean. (*Univ. London Inter. B. Com.*, 1921.)

26. Discuss shortly the trade and importance of the Panama Canal. (*Univ. London Inter. B. Com.*, 1923.)

27. What do you understand by a geographical "hinterland"? Discuss the hinterlands of any two of the great seaports of the Mediterranean. (*Univ. London B A. Pass*, 1916.)

28. Draw a sketch map to show the principal ocean trade routes passing through the Panama Canal. (*Univ. London Higher Schools E*, 1932.)

29. Show by a sketch map the chief trade routes (marking the ports) of the Indian Ocean. (*Univ. London Inter. B. Com.*, 1932.)

30. Show how the general distribution of land and water over the earth's surface has concentrated ocean routes on the Panama and Suez Canals. (*Univ. London Higher Schools B & D*, 1932.)

31. Select a major port in the Southern Hemisphere and analyse the factors which have led to its growth. (*Univ. London Inter. B.Sc.* (*Econ.*), 1932.)

32. Draw a sketch map to show the chief trade routes of the Atlantic Ocean, indicating the terminal ports and their hinterlands. (*Univ. London Inter. B.Sc.* (*Econ.*), 1933.)

CHAPTER XV

AERIAL TRANSPORT

THE rapid progress of military aviation during the Great War of 1914–18 was not followed immediately by a correspondingly rapid development of civil aviation. For some time there was doubt as to which would be the main line of future progress :—

(*a*) With lighter-than-air machines, dirigibles consisting of an envelope filled with hydrogen or other light gas. These airships have the advantages of long range (since they can carry large quantities of fuel and hence are capable of trans-oceanic flights of great length) and a large carrying capacity whether for passenger or goods. On the other hand they are very expensive to construct, comparatively slow (the normal speeds being about half those of aeroplanes), unwieldy and difficult to handle (especially in wind) and requiring very expensive hangars and mooring masts.

(*b*) With heavier-than-air machines whether adapted for landing on land (aeroplanes or airplanes), on water (hydroplanes and flying boats), or on either (amphibians).

After tragic disasters both Britain and the United States have virtually abandoned lighter-than-air machines ; Germany is the only country which achieved a certain amount of success with these, and with the " Graf Zeppelin " maintained a regular trans-Atlantic service to South America.

Judging from the present position it is doubtful whether transport by air will ever seriously challenge rail- and ocean-transport for the heavier and bulkier commodities of commerce. But where speed is the first consideration aerial transport daily becomes increasingly important for passengers, mail and articles of small bulk or weight but high value.

Speed.—The larger air liners now travel regularly at between 100 and 150 miles per hour ; mail-carrying planes can travel at over 200 m.p.h., and the air speed record is over 440. These speeds may be compared with typical speeds for ocean liners (speed usually expressed in knots or nautical miles of 6,080 feet per hour ; here converted to land miles per hour for purposes of comparison) of 12 to 18 m.p.h. or record speeds by " ocean greyhounds " such as the 79,000 ton *Queen Mary* of over 35 m.p.h. (30 knots).

Time.—A few comparisons will serve to indicate the saving in time resulting from the use of aerial transport :—

Journey	Record Time	Approximate normal schedules		
		Air-mail	Train	Ocean liner
New York—Los Angeles . . .	10 hours	20 hours	3½ days	16 days
New York—Buenos Aires . .	—	5 days	—	16 days
London—Sydney	3 days	10 days	—	30 days
London—Bombay	1 day	4 days	—	18 days
London—Durban	2 days	5 days	—	17 days
London—Mombasa	—	3½ days	—	17 days
London—Moscow	—	12 hours	2½ days	—

Loads.—Some aeroplanes in regular use carry as many as 40 passengers, and four-engined planes developing 2,200 h.p. are frequent, but a good general idea of planes most commonly used will be apparent from this table of Imperial Airways services to Australia and South Africa :—

Stage	Passengers	Staff	Total weight loaded
London—Paris	13	4	13·4 tons
Southampton—Durban (flying-boat)	16	5	18·0 „
Southampton—Australia (flying-boat)	16	5	18·0 „
Khartoum—Lagos and Accra .	11	2	8·9 „

Costs.—Inland air routes can be operated as cheaply as one shilling per ton mile, equivalent to about one penny per passenger per mile, but these costs refer to only the most favourable conditions. From New York to Los Angeles (2,633 miles) the fare is $160 or 3*d.* per mile ; New York to Buenos Aires £115 or 4*d.* per mile ; London to Durban £125 or 4*d.* per mile ; London to Sydney (13,000 miles) £160 or about 3*d.* per mile.

Air ports.—According to the availability of smooth stretches of land or sheltered stretches of water aeroplanes or hydroplanes may be the more suitable for use on given routes, but in a surprisingly large number of cases, especially in undeveloped countries, hydroplanes are the more generally useful. A lake, a stretch of river or a sheltered bay provides a natural landing ground for hydroplanes ; an aerodrome on land requires both preparation and upkeep. Modern airports are fully equipped with wireless and the planes are never out of touch through wireless telephone ; night flying is made possible by powerful illumination of landing grounds. Regular routes in Europe and North America are marked out by beacons, illuminated at night, and other signs.

Air lines.—Commercial air lines at the present day fall into several groups :—

(*a*) Those established in thickly populated countries for the rapid transport of mail and passengers. Most of the lines forming a network over the whole of Europe and the United States belong to this category. They are in direct competition with alternative means of transport—rail and road—but are increasing rapidly in importance. In August, 1919, the first air service for passengers and freight—the first of its kind—was established between London and Paris. To-day, in a busy season, more than 500 passengers cross the Channel in a single day.

(*b*) Those which afford links with distant cities, often difficult of access by other means. The South American air lines serve places which cannot be reached directly either by rail or road, and the same is true of Australia, Africa and of vast areas in eastern Asia, notably China.

(*c*) Those which are partly commercial and partly strategic in importance such as some of the French lines in Africa.

(*d*) Those which are not served by regular services and can be described as "tramp lines." It is interesting to notice in this connection the use of light planes in such services as the medical service in Australia. The wireless and telephone have brought within call of isolated farms the services of a doctor 300 or 400 miles away.

Two maps have been drawn to show some of the principal regular long-distance routes now in operation.

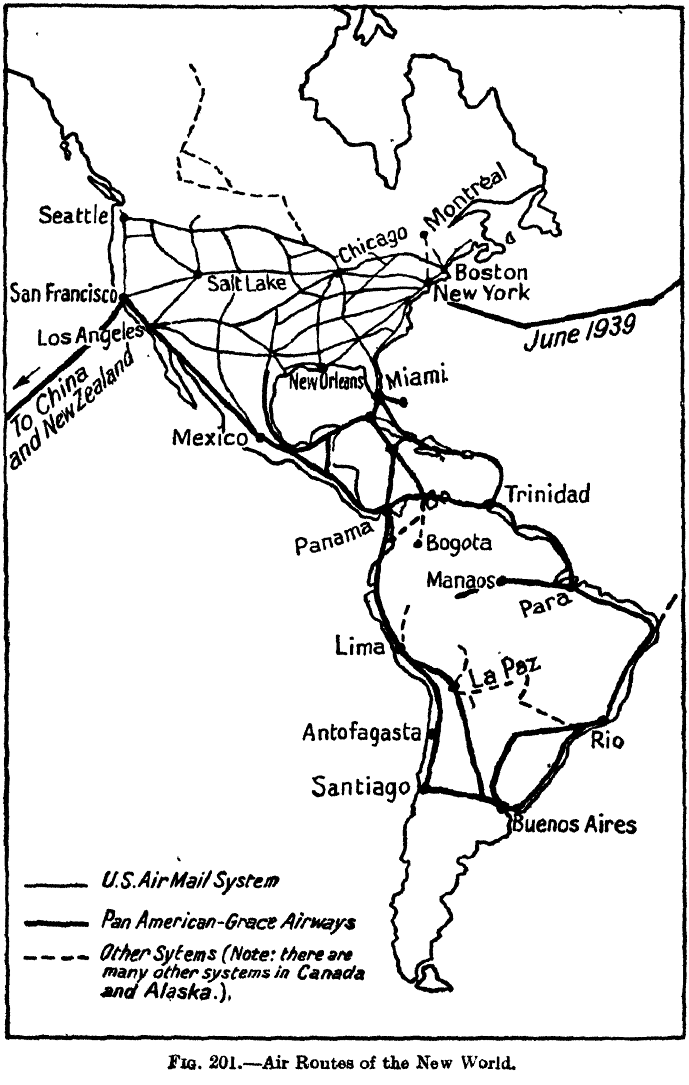
Seattle
San Francisco
Los Angeles
To China and New Zealand
Salt Lake
Chicago
Montreal
Boston
New York
June 1939
New Orleans
Miami
Mexico
Trinidad
Panama
Bogota
Manaos
Para
Lima
La Paz
Antofagasta
Rio
Santiago
Buenos Aires
U.S. Air Mail System
Pan American-Grace Airways
Other Sytems (Note: there are many other systems in Canada and Alaska.),

FIG. 201.—Air Routes of the New World.

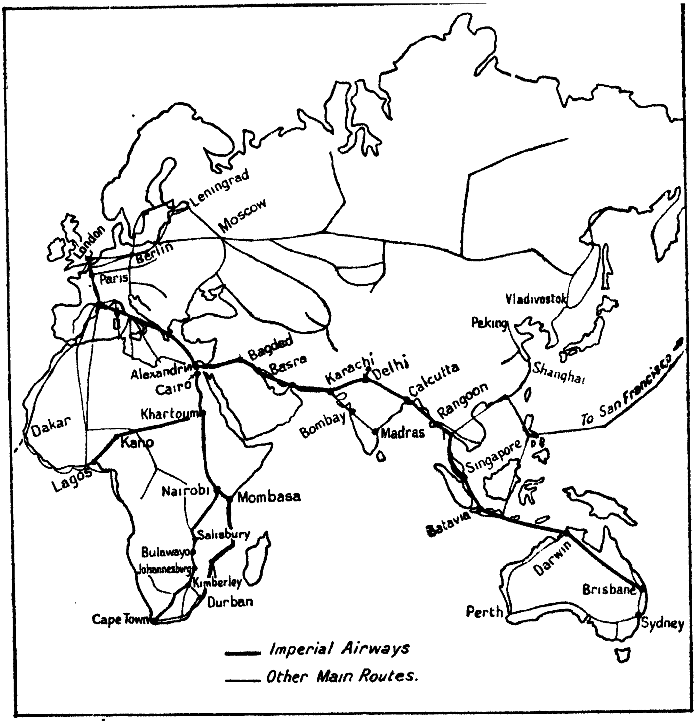
Leningrad
Moscow
London
Berlin
Paris
Vladivostok
Peking
Bagdad
Basra
Alexandria
Cairo
Karachi
Delhi
Calcutta
Shanghai
Khartoum
Dakar
Rangoon
To San Francisco
Bombay
Madras
Kano
Singapore
Lagos
Nairobi
Mombasa
Batavia
Salisbury
Bulawayo
Johannesburg
Darwin
Kimberley
Durban
Brisbane
Perth
Cape Town
Sydney
Imperial Airways
Other Main Routes.

FIG. 202.—Air Routes of the Old World.

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