PRINCIPLES OF GENERAL GEOGRAPHY

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BY

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PREFACE

THE old conception that geography is a description of the Earth still finds acceptance in some quarters in India. As this description, compressed in the short compass of a single book, reduces it to an inventory, to a list of names of places which only a few can ever hope to visit or be interested in, during their whole lives, people still look upon geography as an extremely dull subject, neither useful nor interesting. The futility of geographical studies of this character becomes the more striking when text-books, written by outside writers, naturally from the point of view of their own countries, give unnecessary details of their own countries and skip comparatively hastily over the necessary details about India itself, which, besides being the homeland of Indian students, is in size, population and natural productivity as important as several European countries put together.

Modern geography, however, is not a catalogue of names, but is a study of the Earth as the home of man, and therefore of the environment in which man lives and works. The chief constituents of environment are the position and size of the region, its physical features, its climate, its flora and fauna. All these factors profoundly influence man and control his activities. These activities are, however, so many and so complex that human geography resolves itself into the analysis, study and interpretation of the causal relationships between environment and one particular activity of man. A mountain, river or town is looked upon from very different points of view by different people, according to their own special needs. The army studies mountain ranges, like the Suleimans, the gaps and the breaks, the passes and the saddles, the little streams and their valleys, from the point of view of selecting vantage points for offence and defence. Naval men are similarly interested in ports and harbours, and key positions on important sea routes; and Singapore has a different meaning for them than for others. The architect is concerned about building materials, clay, cement and lime, stone, granite and marble;

he studies the wind system in order to devise the proper system of ventilation, and solves his problems by wind scoops or high domes or tapering gopurams, by flat roofs or sloping ones. The merchant is concerned with the products of different regions, the industrialist with the source of industrial power, markets and transport. The statesman is concerned with almost all points of view together. He is the custodian of all interests for his country, and he has to formulate policies so as to secure the essentials for the army and the navy, for the merchant and the industrialist: indeed for all concerned in the well-being of his country. International policies are determined very largely on a close study of the place-factor, which indeed is geography; relations between nations are governed largely by the knowledge of geographical data and their causal relationships, and geographical knowledge supplies the key to a proper understanding of the main springs that move the lever of international relationships.

This volume of the principles of general geography has been designed to meet the special needs of Indian students. The earlier chapters deal with facts and principles that go to make up the environment, the Earth, its surface, climate, vegetation and animals, and the division of the Earth into natural regions. The later chapters deal with environmental control on man, the development of human life, and the progress and problems of countries. In the preparation of the volume, I am greatly indebted for much of my material to a great many writers; but it is not possible to make acknowledgements to all of them in a detailed manner. I must, however, acknowledge my obligations to well-known text-books on geography for materials for the earlier chapters. Their authors include Dr Mill, Professors Herbertson, Tarr, Unstead and Taylor, Mr Lake, Miss Skeat, Messrs Piggott, Finch and Jameson, and Mrs Ormsby. For materials for the later chapters, I am indebted to the admirable books by Miss Semple and by Professors Whitbeck and Bowman.

H. L. KAJI

Cumballa Hill, Bombay
February 1938

CHAPTER I

THE EARTH

1. ORIGIN OF THE EARTH

THE ancients watched and observed the heavenly bodies and tried to discover the where, why and how of their movements. They believed that the whole heavens with all the constellations of stars moved round the Earth, and this belief found expression in the Ptolemaic System propounded by the great Egyptian mathematician and geographer Ptolemy, and the system was accepted as correct for fourteen hundred years. The Renaissance, however, led to a revival of thinking, and among the many discoveries made was that of a great German astronomer Copernicus. He refuted the Earth-centre belief, and propounded the idea that the Earth was a planet rotating on an axis and revolving round the Sun, which was the centre of the Solar System. Galileo was soon able to lend support to these ideas by his observations with the telescope, then recently invented. Kepler improved upon the Copernican ideas and formulated several fundamental laws. When the movements of the planets were thus better understood and explained, men began to ask why these bodies moved in their particular ways year after year through the ages. It was left to Sir Isaac Newton, the great English mathematician, to answer this question. He showed that gravitation is the one single force, which, acting in many ways, rules the universe. The strength of this force varies directly as the masses of the bodies pulling, and inversely as the squares of the distances between them, so that the larger and nearer the bodies concerned the greater is the pull between them; and it is in this way that gravitation rules the planets and their motions. The same force is further responsible for moulding the shape of the heavenly bodies for, acting from the centre of each body, it subjects every particle thereof to a tremendous pressure towards the centre and thus tends to shape it into a smaller globe. The crushing grip of this centripetal force is, however, counteracted and balanced by the centrifugal force of rotation, which also thus plays a very important part in moulding or shaping the planets.

While gravitation thus explains several of the riddles of the universe, it does not throw any light on the mystery of the creation, evolution and composition of the different worlds in the heavens. Great assistance is, however, now afforded by telescopes and special cameras attached to them, so that with these we can study things which the naked eye fails to see. The spectroscope also affords considerable assistance, inasmuch as it analyses the light from different substances, dividing different colours into various bands of colour, which show straight lines, bright and dark and differing in thickness and in distance apart. The analysis of the light from a celestial body enables us to find out whether it is solid or gaseous and of what substances it is made. But even before the telescope and spectroscope were available, a great French astronomer, Laplace, made a shrewd guess at the way stars and planets came into existence. He imagined that a great rotating spherical cloud of gas, very light and scattered, existed millions of years ago in the heavens, and this, under the effect of the force of gravitation, became intensely hot. Radiation was also at work, and the consequent cooling led to shrinkage. The outer parts cooled and contracted earlier than the interior and became denser and heavier. The contraction in size led to faster rotation, so that rings of the heavy material were thrown off from the surface. These, breaking up in the course of time, were moulded by gravitation into spheres. Continued cooling and shrinkage, accompanied by faster rotation, led to a continual throwing off of rings and to the formation of a system of globes, the planets rotating on the axes and moving round the central mass of gas. These planets would in turn similarly cool, shrink and throw off rings to form the satellites revolving round them, and thus form a solar system like ours. The rings round the planet Saturn lend colour to this **nebular hypothesis**.

Modern research has shown that Laplace's guess is wonderfully near the truth, and that Lockyer's **meteoretic hypothesis** is but a modification thereof. The limitless space of the heavens shows innumerable shining masses, which, under powerful telescopes are seen to be, not stars, but actually nebulae in different stages of development. The spiral nebulae suggest that the outer stars are not being formed out of the central one, but that all are gradually growing together. There exist countless small masses of matter, the meteorites, largely composed of iron, moving in space and drawn by gravitation to passing stars. These meteorites may be brought together under the influence of gravitation to form a nebula. Rotation and gravitation would then act upon it and form huge spheres which would thus form a system of blazing globes. The loss of heat by radiation would change some of these into dead stars or planets which would no longer glow, but shine merely by reflected light.

Chamberlin, however, in advancing his **planetesimal hypothesis,** holds that nebulae are composed of small particles of matter in the solid or liquid state. He considers that when two bodies approach each other, the larger one would throw out protuberances on the sides near and opposite to the smaller one, and that in the course of their rapid whirling movement these protuberances would become denser in some places than in others, with the result that gradually such thickened masses would absorb the remaining material and form planets, while the larger body would form the central Sun.

This planetesimal hypothesis has recently been modified, and the theory is now advanced that when two bodies approach each other, the smaller one, which ultimately becomes the Sun of the System, assumes a shape more or less like that of an egg, the point of the egg being directed towards the larger body. The point would then open out, and, through the opening, gaseous filaments would issue, slowly to start with, and more rapidly later on. With the recession of the larger body, the process would again slow down. These filaments would soon break up and form planets, the smaller being nearest and also farthest from the Sun and the larger ones intermediate in position. This theory seems strangely to be in some accord with the belief in the '**world-egg**', which has been the extraordinarily universal conception of the ancient philosophers of so many different peoples, such as the Norsemen, the Egyptians, the Phoenicians and the Hindus. The egg of gold as large as the Universe produced by the Hindu Creator, Brahma, thus seems to be a conception very similar to that of the egg-shaped Sun, producing the filament and forming the Solar System of the modern scientific theory.

The Earth was probably fashioned in some such way as this. It was at first a huge blazing globe, much larger and less solid than at present. Gravitation compressed the solid meteorites that made up the Earth, and as pressure produced heat, all substances were made liquid or even gaseous; but with the rapid escape of heat into space, the Earth steadily cooled. The continuing pressure of gravitation made the globe smaller and smaller, and this shrinking maintained considerable heat in the interior of the Earth. But as the exterior surface cooled, some gases would become liquids and later on nearly solid. Rocks and metals, being denser and heavier, collected towards the centre of the Earth, forming, after millions of years, a solid and hard crust, while the lighter vapours and gases outside the crust went on cooling more rapidly, so that when the clouds of water vapour cooled sufficiently the first rain would fall. The rock-crust became gradually cooler and more solid and in this process of cooling millions of years have passed. The Earth's heat is, however, not yet exhausted; but it is not known in what physical state the materials exist. Hot springs, geysers, volcanoes, all show us that there is still great heat in the interior, the heat increasing as we descend by one degree Fahrenheit for every sixty feet; but it is probable that the rate of increase falls off with depth. The enormous pressure of the atmosphere, the great masses of water and the crust of dense rocks retard radiation of heat, and explain the continuance of this heat in the interior of the Earth. Radioactivity is also an important factor. The Moon, so much smaller than the Earth, is already dead and cold; and even the Sun, though it is still intensely hot, is slowly cooling. In course of time the Earth will become, like the Moon, dark and cold; though before that happens, with the gradual decrease of the Sun's heat, great fields of snow and ice will gradually advance from polar regions towards the equator and finally hold the whole Earth in their grip. But it is comforting to think that this will not happen for some millions of years to come.

Since the birth and infancy of the earth tremendous changes have taken place on its surface. Continents have been buried deep under the oceans, and new continents have arisen on the surface from the bottom of the vast oceans. Mountain ranges have been heaved up where before were low flat plains, while the great forces of denudation, erosion and weathering have reduced highlands to lowlands. Startling yet rhythmical changes have been observed in the climates during the great geological eras. Three times, at least, have the temperate regions of today been held in a grip of ice, and three times, at least, have the polar regions experienced warm climates. During all these millions of years, there has been a continuous evolution of life forms. All these incidents in the history of the Earth's childhood are revealed by a study of the various beds of rock and the fossils contained in them. This study, however, forms the subject matter of a different science—Geology.

2. SHAPE AND SIZE OF THE EARTH

For ages no one doubted that the Earth was flat. But later, there were philosophers in many of the lands of ancient culture and civilization who believed in the spherical shape of the Earth. Pythagoras and Aristotle of Greece, Ptolemy of Egypt and the great Hindu sages held the belief that the Earth was ball-like, a sphere, but the great mass of the people did not accept the theory and were content to accept the Earth as a flat disc.

Many proofs have been advanced and people generally have now accepted the **spherical shape** of the Earth. The Sun, Moon and the other planets are all spheres ; and this suggests by analogy the same spherical shape for our planet. The shadow of the Earth as observed during lunar eclipses is always circular, and it is only a spherical body which can always throw a circular shadow. The spherical shape of the Earth gains further acceptance by the fact that ships by sailing in one direction continuously have been able to circumnavigate the globe.

In modern times many experiments have been performed to prove the rotundity of the Earth. In 1870, Dr Wallace set up three posts three miles apart in a level stretch of water in the Fen District of England. Their tops were exactly the same height above the water. On looking at the tops of the posts through a telescope placed at the first post, he found that the middle post projected above the line of sight of the first and last. This supplied evidence from which he could calculate the curvature of the Earth. Engineers in constructing a canal have to make an allowance of about eight inches per mile for this curvature. A similar observation may be made at the seaside. All outgoing ships disappear hull first on the horizon, and incoming ships appear masts first on the horizon, thus proving that the surface of the Earth must be curved. Again, the difference in time at various places on the Earth shows that the Earth could not be flat, for if it were, all places would have had sunrise, noon and sunset at the same moment. But it is midday at New York, and 3 a.m. at Sydney, when it is 10.30 p.m. with us in India. The Sun or the stars when observed at the same time from different places on the Earth have different heights above the horizon, and this cannot be the case unless we admit the curvature of the Earth's surface. Further, the horizon is always circular in shape, and this is possible only on a spherical surface. As an aeroplane rises in the air, the circular horizon increases steadily, and this could not happen if the Earth were flat.

The shape of the Earth is not, however, quite spherical. A spherical body, not sufficiently rigid, rotating on its axis, like a lump of clay on the potter's wheel, is bound to bulge at the equator. Newton therefore held the Earth to be an **oblate spheroid,** that is, a spherical body flattened at the poles, more or less like an orange. The dissimilarity in form of the two polar regions and the existence of flattening on the sides, suggested, later on, that the Earth's shape was due to something like the collapse of a pear-shaped body on cooling, which would then assume a **tetrahedral shape.** The principal mountain ranges on the Earth's surface, if the tetrahedral theory were true, must have been formed roughly about the same time; but as a matter of fact great intervals separate the chief mountain-building movements. The compression on the sides that is present is further not sufficient to make the Earth a tetrahedron. We might therefore call the peculiar form of the

Earth—pear-shaped, like a top, with sides somewhat compressed —a **geoid,** i.e. **an earth-shaped body.** For all practical purposes, however, the geoid differs so little from the sphere that the Earth can well be regarded, not as orange-shaped or pear-shaped, which indeed would be gross exaggeration, but as ball-shaped, spherical.

It is very difficult to measure with absolute precision the **size** of the Earth. The Chaldeans, the Egyptians, the Greeks and the Hindus attempted the problem years ago, but it was left to Eratosthenes, the librarian at Alexandria, to be the first to obtain, as early as 276 B.C., a measurement of the Earth by scientific methods. He observed that the angle which the Sun made with the vertical at noon on midsummer day at Alexandria was $6\frac{1}{2}°$; Syene (near modern Aswan), distant about 450 miles from Alexandria, being on the tropic of Cancer, had the Sun exactly overhead on that day. This gave him figures for calculating the circumference of the Earth which is $\frac{450 \times 360}{6 \cdot 5}$ miles, that is, about 25,000. This measurement by Eratosthenes was not improved upon till the times of Louis XIV of France, when Picard made accurate measurements with the aid of the telescope. Exact measurement, however, depends on the exact shape being known; and our knowledge of the exact form of the geoid being yet far from complete, absolute accuracy in the measurement of the size of the Earth cannot be attained. For ordinary purposes, however, the circumference of the Earth is now accepted as almost 25,000 miles, and the area as about 200,000,000 square miles. The diameter between the poles, where there is a slight flattening, is 7,900 miles; at the equator, owing to the slight bulge, it is 7,926 miles.

3. MOVEMENTS OF THE EARTH

The Earth has two motions, which have far-reaching influences on human life. The Earth rotates on an axis passing through the poles once in twenty-four hours. The rotation of the Earth causes the periods of light and darkness, day and night, and is also probably the reason why the Earth acts as a huge magnet. A compass needle has one end pointing to the north magnetic pole and the other end to the south magnetic pole.

Rotation of the Earth. It is hard to realize the fact of the daily **rotation of the Earth.** We still use the terms **sunrise** and **sunset,** though we well know that it is the turning of the Earth on its axis that makes the Sun appear to rise and set. But in attempting to explain the alternation of day and night, it is surely more reasonable to accept the fact that the smaller body, the Earth, rotates, rather than that the Sun and the starry firmament go round the Earth once in every twenty-four hours. The illusion of the revolution of the starry firmament round the Earth is caused by the rotation of the Earth itself, much in the same way as a railway train in which we are seated appears to us to move backwards, when another train drawn up parallel to ours on the other side of the station platform begins to move in the direction from which we have come. The falling, slightly towards the east, of a stone dropped from the top of a high tower is, however, a proof of the west-to-east rotation of the Earth ; but the best proof is afforded by Foucault's experiment with a heavy pendulum hanging from the centre of the ceiling of a lofty building, when it was so arranged that the plane of the swing of the pendulum remained unaffected. The pendulum length was so adjusted that its point traced a line at each swing for a short distance along the floor of the building, and the marks clearly showed that the floor itself, with the building, and indeed the whole Earth, was turning round.

Daylight does not last for the same number of hours at all places on the Earth, nor does it last for the same number of hours at any one place all the year round. In India, its duration varies from 11 hours in winter to 13 in summer. The variation is not so great in India as in cool temperate regions like England, where daylight varies from 8 hours in winter to 16 hours in summer. These variations and differences are due to the other motion of the Earth, its revolution round the Sun, coupled with the inclination of the axis of rotation to the plane of revolution.

The orbit of the Earth is elliptical, though very nearly a circle. It is not in the same plane as the equator of the Earth—the great circle half-way between the poles—but is inclined to it at an angle of $23\frac{1}{2}°$. The axis is therefore inclined to the plane of the Earth's orbit, but it remains pointing in the same direction during the whole revolution. It is this revolution of the inclined Earth round the Sun, once in about $365\frac{1}{4}$ days, that causes the variation in the length of the day at different places and at different periods of the year, and the regular succession of seasons.

Inequality of day and night. The Earth in the course of its revolution round the Sun occupies the various positions as shown in Fig. 1, and a study of these positions will show

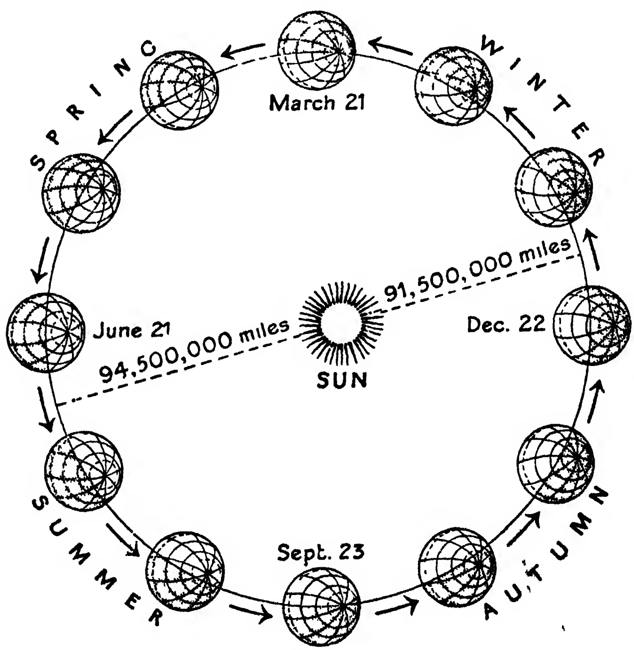

FIG. 1. Seasons—northern hemisphere

how day and night are of unequal length at different places on the surface of the Earth and at different times of the year. We shall examine this inequality at (i) the equator, (ii) at Bombay, (iii) at the Arctic and Antarctic Circles, and (iv) at the poles, in four of these twelve monthly positions (Fig. 2).

In the December position, a point on the equator passes along the line *EE* as the Earth rotates. Half of *EE* is in light, the other half in darkness. The same is the case with the side of the Earth not shown in the diagram, and the point *B* has day and night for half the period of rotation. We thus see that all places on the equator have twelve hours of light and twelve hours of darkness, no allowance being made for twilight. In the March, June and September positions, the situation is the same, and we thus see that throughout

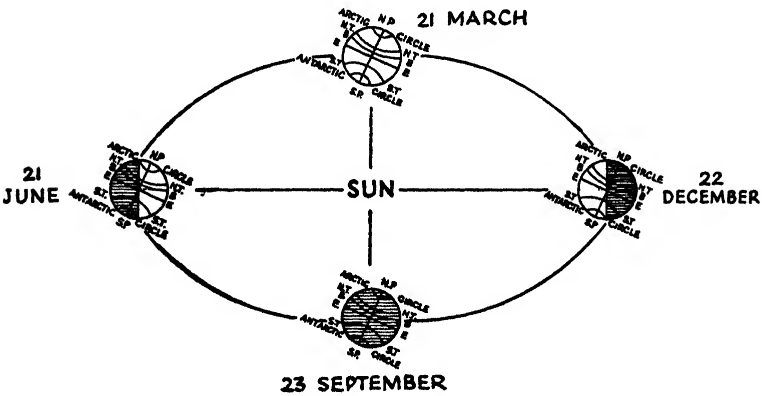

FIG. 2. Inequality of days and nights

the year at the equator, days and nights are equal, the Sun rising each morning at 6 a.m. and setting each evening at 6 p.m.

If we now consider the conditions in the latitude of Bombay, 18° 55′ N., as typical of places between the equator and the tropic of Cancer, we find that a point representing Bombay would pass along the line *BB*. In the December position, a little less than half the rotation is in light and a little more than half is in darkness; daylight therefore lasts about 11 hours, the Sun rising at about 6.30 a.m. and setting at about 5.30 p.m. In the June position, the conditions are reversed and daylight lasts for about 13 hours, the Sun rising at about 5.30 a.m. and setting at about 6.30 p.m. In the March and September positions, they are intermediate between those of December and June, and day and night are of equal length. This inequality of the days and nights is accentuated greatly at places in higher latitudes. For instance, in London, 51° 30′ N., the length of the day varies from 8 hours in winter to 16 hours in summer.

The parallel of latitude 66½° N. is known as the Arctic Circle. No point on the Arctic Circle enters the lighted half of the Earth at all in the December position ; at one moment only it just reaches the borderland between light and darkness. At this time of the year, therefore, the Sun remains below the horizon all the time, just touching the horizon for a moment, and the Arctic Circle is enveloped in darkness for all the 24 hours. The June position shows a complete reversal of these conditions. The Sun is above the horizon all the time, just touching the horizon for a moment and the Arctic Circle has daylight for all the 24 hours. This moment when the Sun touches the horizon corresponds to midnight at places nearer the equator on the same meridian, and explains the phenomenon of the ' Midnight Sun ' at places within the Arctic Circle. The March and September positions give equal days and nights to places in this latitude also. Conditions at the Antarctic Circle 66½′ S. are similar but opposite to those obtaining at the Arctic Circle. The twenty-four hour day occurs in December and the twenty-four hour night in June.

At the North Pole itself, there is, theoretically, complete darkness in the December position (Fig. 2), which continues till the March position is reached, when it emerges into light. This illumination of the North Pole persists through all the six months from 21 March to 23 September, when it again enters darkness. There is therefore a day of six months, and a night of equal duration at the North Pole. The South Pole has similar conditions, only that its six-months' day begins from 23 September and lasts until 21 March.

Thus we see that (i) at the equator, day and night are equal all the year round ; (ii) the inequality between them becomes greater and more marked as the poles are approached ; (iii) on the Arctic and Antarctic Circles, this inequality becomes so great that once a year there is a day of 24 hours and once a year there is a night of 24 hours ; (iv) at the poles, the days and nights lengthen out to six months ; (v) in the northern hemisphere the days become longer and longer from 22 December till the longest day is reached on 21 June : after this, days become shorter and nights longer till the shortest day is attained on 22 December; (vi) the conditions in the southern hemisphere are just the reverse of those in the northern hemisphere; and (vii) on 21 March and 23 September there are periods of 12 hours light and 12 hours darkness at all parts of the earth. These times are called the **equinoxes** (equal night times) while the June and December times are called the **solstices.** The dates given should be considered as approximate, as there are slight variations due to different causes, one of which is locality. For instance, the winter solstice falls on 22 December each year at the present time; but later in the century, the day in some years will be 21 December.

***Altitude of the Sun.** As the Earth rotates, each point on the equator in turn comes under the direct rays of the Sun on 21 March and 23 September (Figs. 2 and 3).

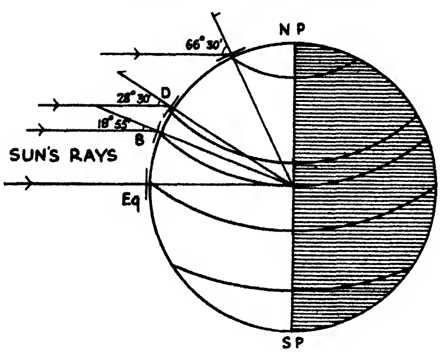

FIG. 3. The equinoxes

At the equator the Sun is vertically overhead at noon, and its altitude is 90° above the horizon. At other latitudes the altitude attained by it at noon on these days is less than 90°. At Bombay, the Sun is 18° 55′ from the zenith and has an altitude of 71° 5′ above the south horizon; at Delhi, the Sun's zenith distance is 28½° and its altitude is 61½°; at the North Pole, the Sun is just on the horizon. On 21 June, the Sun is overhead at noon, not at the equator, but upon the Earth at the parallel of latitude 23½° N., the axis of rotation being inclined at that angle (Fig. 4), so that at the equator itself the Sun's rays strike at an angle of 23½° to the vertical and its altitude is 66½° above the north horizon. At Bombay its zenith distance is 4° 35′ and its altitude is 85° 25′ above the north horizon; while at Delhi, its zenith distance is 5° and its altitude is 85° above the south horizon; and at the North Pole, the Sun is 23½° above the south horizon.

Similarly on 22 December, the Sun is overhead at noon at the parallel of latitude $23\frac{1}{2}°$ S., so that at the equator the Sun at noon is at an angle of $66\frac{1}{2}°$, but above the south horizon. At Bombay, the zenith distance of the Sun at noon is now 42° 25′ so that its altitude is only 47° 35′ above the south horizon; while at Delhi, the zenith distance is 52° and the altitude 38° above the south horizon. At the Arctic Circle on that day

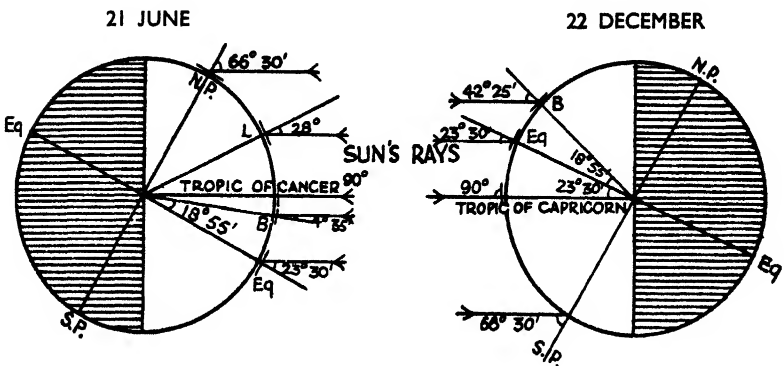

FIG. 4. The solstices

the Sun at noon is just on the south horizon and at the North Pole it is entirely invisible.

Apparent course of the Sun. The revolution of the Earth thus causes the rays of the Sun to strike at different angles on the different parts of the Earth and at different periods of the year. But to an observer on the Earth it appears as if the Sun were moving round the Earth in 24 hours, changing its position every day to sunrise, noon and sunset. At the equator, the Sun on 21 March rises in the east at 6 a.m., climbs up in the heavens till it reaches the zenith at noon and sets in the west at 6 p.m. Each day thereafter, it rises slightly farther north of east, reaches a point in the sky at noon, slightly farther north of the zenith, and sets at a point north of west. This goes on till 21 June when the Sun rises farthest north of east, attains an altitude $23\frac{1}{2}°$ north of the zenith and sets considerably north of west. After this the northward movement ceases, the Sun turns southwards (**dakshina-yana**) and the Sun retraces its steps, until on 23 September, the conditions of 21 March are repeated. The southward movement yet continues and on each successive day, from 23 September until 22 December, the Sun rises farther south of east and sets farther south of west. The Sun attains its lowest altitude on the south horizon on 21 December. The southward movement now ceases and the Sun turns northwards (**uttarāyana**). 21 June and 22 December are thus days when the Sun stops, as it were, before turning back, and these days are said to be **solstices.**

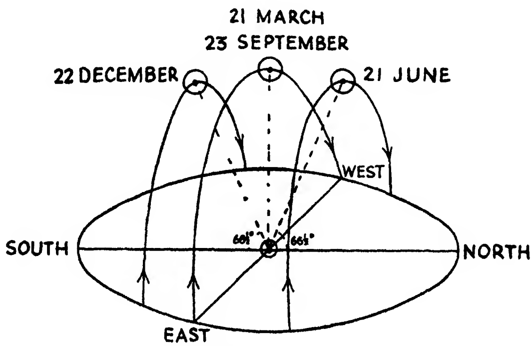

FIG 5 Apparent course of the Sun at the equator

At Bombay, from 21 March, the Sun rises farther north of east each day, attains a greater altitude at noon, and sets farther north of west, so that the path of the Sun is longer each day ; these changes correspond to the earlier times of sunrise and later times of sunset. On 21 June (Fig. 6) the Sun rises

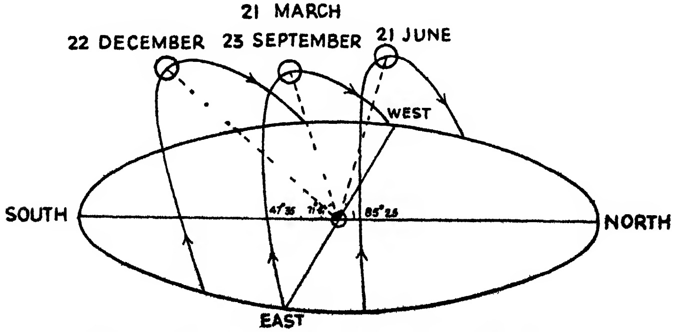

FIG. 6. Apparent course of the Sun at Bombay

in the most northerly position and at the earliest hour; it reaches an altitude of 85° 25′, but above the north horizon, and sets in the most northerly position and at the latest hour. By about the beginning of June, however, the Sun is exactly overhead; and though thereafter it rises farther north of east and sets farther north of west until 21 June, it attains a lower altitude. This high altitude and extended path of the Sun are the cause of summer, and 21 June is therefore known as the summer solstice in the northern hemisphere. From 21 June, the changes are in the reverse direction until 22 December, though in the beginning of July the Sun on its southward path once again attains the maximum altitude and shines overhead at noon. 22 December is the shortest day and the Sun is at its lowest midday altitude; this is the northern winter and 22 December is therefore the winter solstice of the northern hemisphere.

The Sun's rays thus strike vertically at the equator twice a year, on 21 March and 23 September, and once a year at the parallels of latitude 23½° N. and 23½° S., on 21 June and 22 December respectively. At all places between latitudes 23½° N. and 23½° S. the Sun's rays are vertical twice a year, once while the Sun in its apparent path goes from the equator polewards, and once on its return. The parallels 23½° N. and S. are thus turning points and are therefore called **tropics,** the northern being known as the **tropic of Cancer,** and the southern the **tropic of Capricorn.**

Seasons. The orbit of the Earth is elliptical and the Sun is at one of the foci of the ellipse. The Earth, therefore, is not equidistant from the Sun in all its positions during the year. It is nearest the Sun in the December position, when the Sun is said to be in **perihelion,** and farthest in the June position, when the Sun is said to be in **aphelion.** The heating effect of the Sun's rays depends upon the angle at which they strike the Earth, the distance of the Earth from the Sun, and the duration of daylight. From these considerations it is clear that the June position is one of midsummer for the northern hemisphere, and of midwinter for the southern hemisphere; while the December position is one of midwinter for the northern and midsummer for the southern hemisphere; and further, that the summer and winter of the southern hemisphere are slightly more extreme than those of the northern hemisphere. The equinoctial positions in March and September mark the intermediate seasons, spring and autumn respectively in the northern hemisphere, and autumn and spring respectively in the southern hemisphere.

4. LATITUDE AND LONGITUDE

To understand the relations between different places on the surface of the Earth, it is necessary for us to state exactly their positions, distances and directions. On a flat surface, the position of any point can be exactly described easily enough, by stating its perpendicular distances from two straight lines intersecting at right angles. In mathematics we refer to those distances as plus and minus instead of right and left, above and below ; in geography we speak of them as east and west, north and south. To adopt a similar scheme for a spherical body like the Earth, it is, however, necessary to obtain lines corresponding to the axes of reference. There is no given starting point—the origin—and to measure the distances and directions of places on its surface is not easy.

Latitude. The position and direction of the axis of X, however, is suggested naturally. The Earth rotates on its

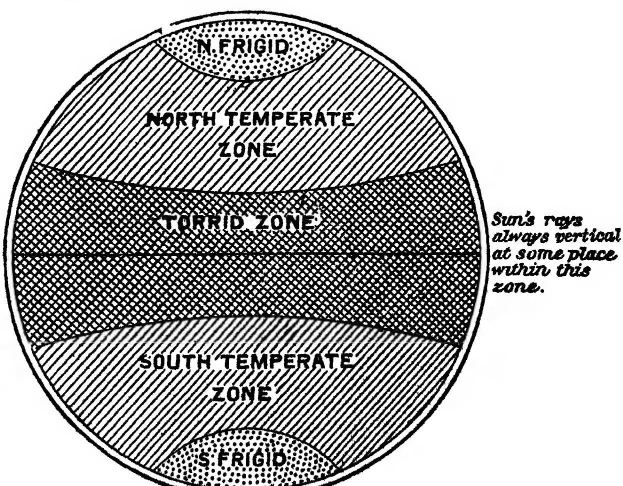

Fig. 7. The zones of the Earth

axis, which gives us two points—the North and South Poles. Midway between them is the great circle, the equator, which gives us a suitable line running east and west for the Y-axis. There are two other particular lines parallel to the equator and north of it, and two similar lines parallel to but south of it. These are the two tropics and the two polar circles—the Arctic and the Antarctic. These five circles give us therefore five belts or **zones** with distinctive temperature and sunshine conditions. The two tropics include the **torrid zone,** on every part of which, as we have seen, the Sun's rays fall vertically at some time during the year. Between the tropics and the polar circles we have the north and south **temperate zones.** The Sun's rays fall more or less obliquely in these zones; but they do receive some rays every day. The north and south **frigid zones** are the polar regions within the Arctic and Antarctic Circles, where there are days when the Sun never appears above the horizon at all.

The rotation and revolution of the Earth and the inclination of its axis thus give us these five naturally fixed parallel lines which are accepted as part of a system of parallel lines. Other lines parallel to the equator can easily be drawn between these, and furnish us with a means of measuring the distance of any point north or south of the equator; that is, its latitude. These **parallels of latitude** are circles smaller than the equator dividing the Earth into two unequal parts. The spaces between them can easily be divided by any number of other lines drawn parallel to the equator. By means of them the distance of any point north or south of the equator, that is, its latitude, can easily be found.

But this system of lines is not sufficient to fix the position of a point. Another series of lines must cut the parallels of latitude at right angles. These run from the North to the South Pole. The direction of the axis of Y is thus fixed naturally. Regular spaces are marked out on the equator, and lines drawn at right angles through the points. These lines are not parallel for they pass through both the poles. They run due north and south, and all points on the same line are north and south of one another and have noon at the same moment, and are equally far east and west of a given point. These lines are therefore called **meridians** (midday lines) of

longitude. One of these lines must, however, be selected as the axis of reference, and from it all measurements east or west should be made. But there is nothing to make us regard any meridian as the best and most convenient. It is natural to find, therefore, that different nations have selected different '**prime meridians**', usually those which run through their national observatories. Thus the ancient Hindus selected the meridian of Ujjain as their prime meridian, the English, that of Greenwich (near London), the French that of Paris, the Germans, that of The Faeroes, and the Russians, that of Pultowa. But since the British Empire is so far flung across the seas and British shipping is so predominant upon the oceans, maps and charts used on ships and calculations made by seamen generally take the meridian of Greenwich as the prime meridian. The network of lines is now complete and the position of any place on the Earth can be exactly determined by stating its latitude, that is, its angular distance in degrees north or south from the equator measured along the prime meridian; and its longitude, that is, its angular distance in degrees east or west from the prime meridian measured along the equator.

The distance along a degree of latitude is about 69 miles; the lines of longitude, however, converge as they approach the poles, and the length of a degree of longitude consequently decreases. It varies from 69 miles at the equator to about 65 miles at Bombay, 64 miles at Calcutta, 34½ miles at 60° and nothing at the poles.

Determination of latitude. Fig. 8 is a section through the centre of the Earth, cut through from pole to pole along the meridian of Delhi, so that the circle $FPDE$ is the circumference, O the centre, PQ the axis and FE the plane of the equator.

The North Pole P makes an angle of 90° with OE, that is its latitude is 90° N. Similarly, the latitude of Delhi, D, is expressed by the angle DOE. Now there is a certain star which is exactly overhead at the North Pole, and is therefore called the Pole Star. The rays from this star, coming from an enormously great distance to the Earth, are practically parallel to any point on the Earth's surface from which the star is visible. ZP represents such a ray at the North Pole and RD at

Delhi. Clearly it is not vertical at Delhi, the vertical direction being represented by DZ' and the horizontal by DH. The Pole Star has an altitude not of 90° at D, but one represented by

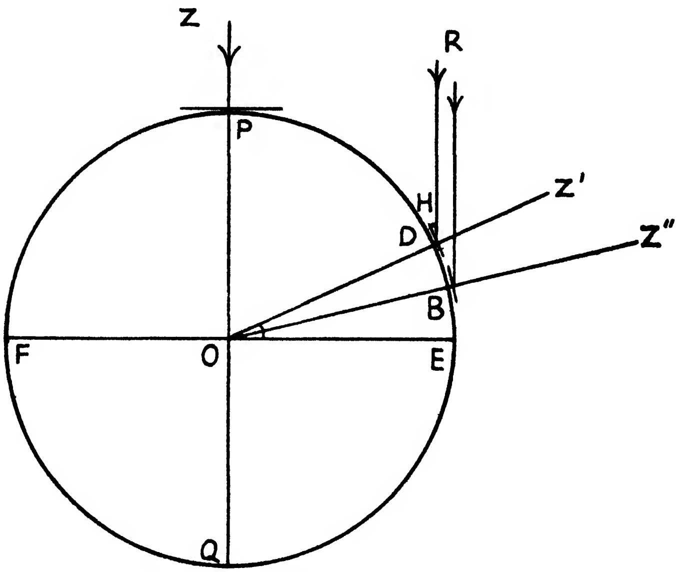

FIG. 8. Latitude and the Pole Star

the angle HDR. This angle is equal to the angle DOE or the latitude of Delhi. Hence the latitude of a place in the northern hemisphere is equal to the altitude of the Pole Star above the northern point of the horizon, which must thus be observed to find the latitude of any place in that hemisphere. In the southern hemisphere the stars visible there may similarly be made use of for the determination of latitude of places there.

The altitude of the Sun on any given day at any given place may also be used to find its latitude. On 21 March and 23 September, when the Sun is overhead at the equator, the zenith distance of the Sun at any place is equal to its latitude. At other times, allowance has to be made for the declination of the Sun, that is, the number of degrees it has travelled north or south of the equator in its apparent annual path, the latitude being equal to the zenith distance of the Sun *plus* or *minus* the declination, as can be seen from Fig. 9.

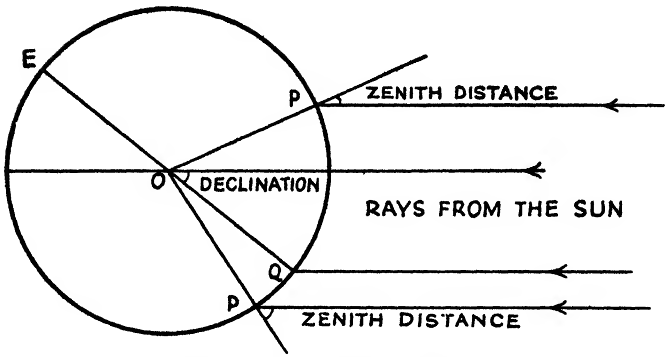

FIG. 9. Latitude and the zenith distance of the Sun

Longitude and time. The meridians are all half-circles having noon at the same time. Let us suppose it is noon at Greenwich ; then all places on the same meridian as Greenwich also have noon at that time. But places to the east of Greenwich have already had their noon, while places to the west have not yet reached their noon. There is thus a definite relation between longitude and time. As the Earth rotates through 360° in twenty-four hours (or as apparently the Sun moves round the Earth in twenty-four hours), a difference of 15° of longitude corresponds to a difference of one hour in time, and 1° of longitude corresponds to 4 minutes in time. Knowing this, we can imagine how people in other parts of the world are employed. When we in Bombay have noon and are busy with our daily work, the man in London is perhaps preparing to get out of bed, the time there being about 7 a.m. ; the miner in Denver, U.S.A., is fast asleep after the day's hard toil, it being just about midnight there ; and the Australian at Sydney may just be playing a game of tennis, as it will be about 5 p.m. there.

Local time at a place is determined by its noon, the time when the Sun attains its maximum elevation for the day. A knowledge of its longitude will therefore enable us to find its local time; and, conversely, a knowledge of the local time of a place, determined by observations of the Sun, particularly by ships at sea, will enable us to find the longitude, that is, how far the place is east or west of Greenwich.

Standard time. Much confusion would result, however, if every place used its own local time based on its midday as shown by the Sun. We should find Surat clocks a little slower than those at Bombay, Poona clocks a little faster and those at Calcutta much faster. It is usual, therefore, for all places within a homogeneous political or natural area to adopt the local time of the capital or chief town in that area as its time; this is called the **standard time.** Thus, the standard time recognized in India before Lord Curzon's regime was the local time at Madras. Important cities like Bombay and Calcutta kept their own local times, but in all Government offices and on railways, Madras time was adopted for the whole of India. For small countries like Belgium and Switzerland a special standard time is not only hardly necessary, but is inconvenient in these days of rapid locomotion and world-wide trade; such countries may adopt the standard time of a great neighbouring country. In the same way, it would be absurd for a very large country stretching far east and west to have only one standard time, for if this were so, the true noon might be indicated on the clocks at, perhaps, 10 a.m. or 2 p.m. The United States of America, for example, has therefore four time belts. The standard time may be based upon the longitude of one or more important central places in the country. But the development of commercial relations and of rapid means of communication has rendered it necessary to fix the standard times of all the different parts of the world so that they may be in an easy and simple relation to one another—differing by whole hours or halves, if possible. Such standard times are sometimes called **zone times.**

Instead of the Madras time, therefore, another time was adopted for India in 1905 as the Indian standard time. It is based on the meridian of $82\frac{1}{2}°$ E. so that it is exactly $5\frac{1}{2}$ hours in advance of Greenwich time, which is the standard time in Great Britain. The Bombay local time is 39 minutes behind the Indian standard time and the Calcutta local time is 24 minutes in advance.

It is interesting to recall the great controversy that raged, and the battles royal that were fought within the Municipal Corporation Hall of Bombay on the adoption of the Indian standard time. The Oppositionists, ably led by

Sir Pherozeshah Mehta, inspired by local patriotism and by ideas about true sunset and the time for evening prayers,

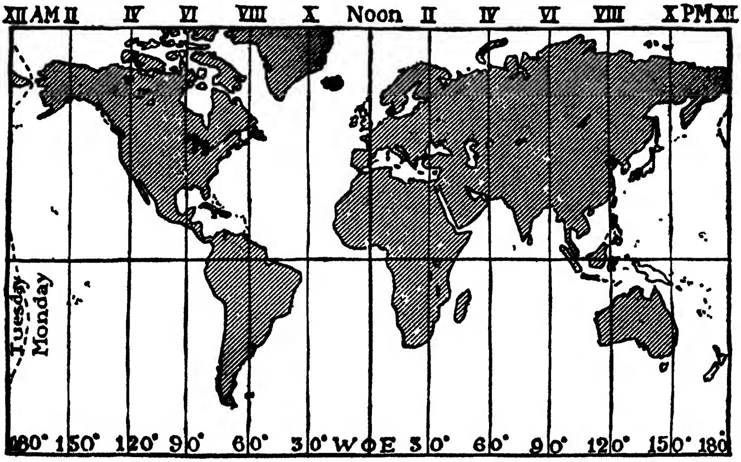

FIG. 10 Time zones (- - - indicates date-line where not 180°)

ultimately won, and the municipal clocks of the City of Bombay still show Bombay local time. Calcutta, too, observes its own local time.

Time zones. The principal time belts now recognized by the different countries of the world are shown in the following table :

Countries	Difference from Greenwich time	Central meridian
The British Isles, France, Belgium, Holland, Spain, Portugal, Algeria (West European time)	None	0°
Germany, Italy, Switzerland, Denmark, Norway, Sweden, Austria, Czechoslovakia, Hungary, Yugoslavia, Albania, Angola, S.W. Africa, Tunis, Belgian Congo (Mid-European time)	1 hour ahead	15° E

Countries	Difference from Greenwich time	Central meridian
Russia, Roumania, Bulgaria, Turkey, Greece, Egypt, Anglo-Egyptian Soudan, Uganda, Kenya, South Africa (East European time)	2 hours ahead	30° E
Mauritius	4 hours ahead	60° E
India, Ceylon (Indian standard time)	5½ hours ahead	82½° E
Burma	6½ hours ahead	97½° E
Straits Settlements	7 hours ahead	105° E
Hong Kong, Borneo, West Australia	8 hours ahead	120° E
Japan and Korea	9 hours ahead	135° E
South Australia	9½ hours ahead	142½° E
Eastern Australian States	10 hours ahead	150° E
New Zealand	11½ hours ahead	172½° E
America: Brazil, east coast, or Atlantic	3 hours behind	45° W
Intercolonial (Halifax), Argentina, Brazil, interior	4 hours behind	60° W
Eastern (New York)	5 hours behind	75° W
Central (St. Louis), Panama to Chile in South America	6 hours behind	90° W
Mountain (Denver)	7 hours behind	105° W
Pacific (San Francisco)	8 hours behind	120° W

Date-line. When a ship sails eastwards from London round the world, it finds that the day is shorter than usual. After some time, when its chronometer set to Greenwich time shows midday, the Sun gives 2 p.m. The Sun seems to be thus daily gaining on the chronometer. Arriving finally back in London, its clock shows approximately correct time once again, but it is wrong in the day of the week by just one day. It has been gaining at every stage of the voyage, so that the gain amounts in the course of the voyage to a whole day, and the ship arrives back on a day which it would call Monday, though it is Sunday in London. If the ship travels westwards, it will lose a day in the course of its circumnavigation of the globe. This apparent gain or loss of a day has now been arranged for by the adoption of a **date-line.** This line roughly corresponds to the meridian of 180° and lies mostly on water, diverging from 180° only to avoid the small islands or groups of islands through which it would otherwise pass. A ship arriving at that line at, say, 6 a.m. on a Sunday, changes its date going eastward to 6 a.m. on the Saturday previous, while going westward it would change from 6 a.m. on Sunday to 6 a.m. on Monday. Thus a day is taken twice when going eastward and dropped when going westward.

5. MEASUREMENT OF TIME

The movements of the Earth have given to us our units of time. The rotation gives us the cycle of light and darkness and therefore the small unit, the **day**; the revolution gives us the cycle of seasonal changes and therefore the large unit, the **year.** These two natural divisions have been almost universally adopted in all ages and in all countries for building up a system of measuring and recording time, and are the foundation of calendars. The Sun, to the primitive man, was indeed the watch marking off the days. The day does not, however, mean the same thing for all people; the point of commencement is different with different people. The Hindus begin their day from sunrise, the Mohammedans from sunset, the Christians from midnight, and astronomers from midday.

The length of the solar day varies, for although the Earth is a timepiece which does not require winding, it travels faster at some parts of its orbit, the **ecliptic,** than at others. The average of all the apparent solar days in the year, that is, the mean solar day, is what the clocks are made to mark, and they thus indicate **mean time,** while a **sundial** shows the Sun's time, or apparent time. The difference between apparent and mean time is called the **equation of time.**

In addition to these two units, the day and the year, we need others to measure periods of time smaller than a day, and intermediate units for periods greater than a day, but less than a year. The smaller units are naturally given to us by the four points of time, **sunrise, midday, sunset** and **midnight.** These give us halves and quarters. The Hindus have proceeded one stage farther and use eighths also, each eighth being called a **prahar.** For still smaller units, the Hindus adopt the sexagesimal system according to which they divide the whole day into 60 **ghatikas,** a ghatika into 60 **palas** and a pala into 60 **vipalas.** The Christian nations have adopted the halves, day and night, though from the great variations in the length of the days and nights in the higher latitudes where they have their homes, one would expect them to treat the day as a whole for the purposes of subdivision. They, further, subdivide each half into twelve periods—the **hours.** The hour is divided into 60 **minutes** and a minute into 60 **seconds.** The day is thus a natural division of time, while the ghatika and the hour are artificial ones.

The year consists of 365 days, 5 hours, 48 minutes and 46 seconds, that is, approximately 365¼ days, and roughly 365 days. This awkward relationship between the two great natural units of time does not permit of a simple intermediate unit, and it is the fitting in suitably of this intermediate unit that gives us our different calendars. In this connexion, the second great luminary of the Earth, the Moon, comes to man's help. The Moon completes its revolution round the Earth in about 29½ days and this period is adopted more or less as the intermediate unit, the **month.** The Moon is in a way an excellent date-marker on the wall of the heaven and gives us a very natural calendar. Its phases record as it were the days, the size and shape of the Moon visible from the Earth, changing from day to day, from New Moon to Full Moon and back to New Moon through the intermediate phases, crescent, quadrature and gibbous. The lunar month being taken to be, in round figures, one of 30 days, we have two natural subdivisions, the **fortnights,** the waxing Moon from the New Moon to the Full, and the waning Moon from the Full Moon to the New; while the quadrature gives us halves of these fortnights, the **weeks** of seven days each.

The Hindu calendar. The Hindus have adopted the lunar month of 30 **tithis** (dates), though of 29½ days. From the **Amawasya** (New Moon) to the **Poornima** (Full Moon), it is **Shukla paksh** or **Sudi** (bright half) with tithis 1 to 15; from the Poornima to the Amawasya it is **Krishna paksh** or **Vadi** (dark half), with tithis 1 to 14, the Amawasya being called the 30th date. Thus the tithis do not agree with the **wars** (days) formed into groups of seven named after the Sun, the Moon and the five major planets. On the New Moon day, the Sun and the Moon are in conjunction; on the Full Moon day they are in opposition, i.e. the distance between them is 180°. Each tithi is thus a fifteenth part of 180°, that is 12°, and has to be calculated from the relative movements of the Sun and the Moon and shown in annual **panchāngs** (almanacs) carefully prepared. The varying velocities of the Sun and the Moon make the tithis of unequal lengths, and a particular tithi might thus be greater than a day while another might be smaller. The tithi at sunrise gives the date to the day of the week, and the Hindus have therefore sometimes a tithi repeated and sometimes a tithi dropped.

There are twelve signs (**rashis**) or groups of stars in the zodiac each named after the shape of some animal or object it is roughly supposed to outline.

The Sun in its annual course passes through these twelve signs, and the period required by it to pass through one of these signs is known as a **solar** month. The Sun enters the first point of Aries on 21 March, the first point of Cancer on 21 June, the first point of Libra on 23 September, and the first point of Capricorn on 22 December. But the solar months are of unequal lengths on account of the changing velocity of the Earth during its revolution. If, however, these months be adopted, the difficulties of adjusting the twelve months which constitute the solar year disappear. But it has been found hard to ignore the claims of the Moon as the date-marker and the month-maker. Thus, while all peoples accept the solar year as consisting of 365 days and a little over, they differ in the manner in which the year should be divided into twelve months. Whichever method be adopted, however, the fractional number of days in the year is bound to leave a greater or less surplus which cannot be ignored if the solar year representing the cyclic seasonal changes is to be adhered to, and which therefore leads to the introduction of the **principle of intercalation.**

The Hindus adopt the lunar month and twelve such months give them a year of 354 days. This **lunar year** is shorter than the solar by about 11¼ days, and this shortage amounts to about 30 days in two years and eight months, too serious to be any longer ignored. They introduce, therefore, after two lunar years and eight months have passed, an intercalary month (**adhika masa**). This intercalation is not done in an arbitrary fashion. To maintain the correspondence of the lunar month series with the solar month series, it is obvious that each lunar month should have one, and only one change of the Sun from one zodiacal sign to the other. That lunar month which has therefore no sign-change (**sankranti**) is regarded as an additional, intercalary, leap month (adhika masa) while the one which has two sankrantis is dropped (**kshaya masa**). The additional, the thirteenth, month comes in every third year, but the dropped month comes in only once in about 141 years. The Hindu calendar, strictly based on natural phenomena and astronomical calculations becomes, however, very complex for ordinary use, with its solar days and lunar tithis, with its adhika masa and kshaya masa.

Mohammedan calendar. The Mohammedans, like the Hindus, have adopted the lunar year, but do not seek to bring about correspondence periodically with the solar year, except for **najumi** or astronomical purposes. For ordinary purposes they are content with the lunar year of 354 days. The Mohammedan year has therefore gradually receded by about one-third of a month for every year, and the commencement of the new year has no relation to any seasonal change. Their **Muharram,** the first month of their Hejira year, now falls late in March, though about eighteen years back it fell in September, and passes through all the seasons once in about thirty-six years.

Parsi calendar. The Parsis held to the Sun and ignored the Moon. Uniformity, a great asset in calendar making, made them adopt twelve equal months, each of thirty days. Strangely, they have no week ; the days are not named after the planets ; their thirty days have thirty names. They have thus a year of 360 days. The five days of the solar year not included in their twelve months are regarded as **the Gatha days,** an appendix, the year-closing period, the Divali of the Hindus. This simple, practical and convenient arrangement still leaves about a quarter of a day out of account. This surplus amounts to one day every four years and they could have added a leap day every fourth year, making it the sixth gatha day. But they have chosen to ignore this small surplus till it amounts, in 120 years, to thirty days, that is one month, when they add an intercalary month, the **Kabisa.** When the immigrant Parsis had settled in India, the time came for the addition of the Kabisa. But one section of the Parsis did not agree to the introduction of the thirteenth month, and are known as the **Kadmis** ; the large majority accepted the Kabisa and are known as the **Shehanshahis.** Later, these Shehanshahis too began to ignore the Kabisa, and their new year day, the **Pateti,** falls just thirty days later than the Pateti of the Kadmis. Both Patetis, therefore, have been receding year after year, and while they now fall, one in August and the other in September, in about 500 years the Parsis will celebrate their new year in April-May. Recently this little community was greatly agitated on the question of calendar reform, but like the practical people that they are, they are content with this slow recession of their calendar, which can hardly seriously inconvenience the present or the next generation.

Christian calendar. The Christian calendar is based on an earlier Roman calendar, which is said to have had a year of 304 days divided into ten months beginning from March. Later, two months (January and February) and one additional day were added, and the months were alternately of 30 and 29 days, making a year of 355 days. But confusion arose and in the year 46 B.C. Julius Caesar asked the help of the Egyptian astronomer Sosigenes. The calendar was recast, and the twelve months were given 31 and 30 days alternately, except that February was to have 29 in ordinary and 30 in leap years. The fifth month (counting from March) received his own name; hence the present name of July. Augustus Caesar, the first Roman Emperor, gave his name to the month following July, and made this month also one of 31 days, at the same time taking one day from February. In this way the Roman calendar empirically assigned the days of the year to the different months. The intercalation of the leap day makes the year 11¼ minutes too long, and this error in 128 years throws the calendar out by a whole day. This was rectified by Pope Gregory in 1582 by calling 5 October 14 October, and by arranging that the century years should not be leap years, though every fourth century year should remain so. Even this empirical rectification does not make the Gregorian calendar now in use among the Christian nations (Russia still retains the old Julian calendar) perfectly accurate, for we are now losing three leap years in 400 years instead of 384 years.

Calendar reform. Among Christian nations, payment of wages is commonly made weekly, though we in India are used to monthly salaries and daily wages. Certain reformers, desiring simplification, have recently been concerned with trying to bring about an easy relation between the year and the week. As it is, there are 52 weeks and 1 day in the year. Each year therefore commences on the week day next after the one which marked the commencement of the previous year, unless that was a leap year, when it commences on the second day after. Date sheets are therefore necessary to enable us to know the days of the week corresponding to the different dates in the different months in the year. The League of Nations has taken up the question of calendar reform, and is suggesting the adoption of 13 months each of 28 days or 4 weeks, the 365th day being the New Year's Day, and regarded by itself and independent of any week day. The Leap Day similarly would be by itself, not falling on any week day. If this arrangement be adopted, the same date in the same month would always fall on the same week day. But to change the habits of generations is not easy, and the Christian nations are content to carry on with the Gregorian calendar, imperfect and empirical though it may be.

6. MAPS—AND MAP-MAKING

Maps are plans or representations on a small scale of a part of the Earth's surface, prepared for many different purposes and from many different points of view, and present the features of the Earth in a pictorial or diagrammatic manner. Good maps, well made, properly read and wisely interpreted furnish us at a glance with a wealth of information in its correct perspective, and are therefore worth pages of written description. But the eye can take in at a glance for purposes of study only a limited space, and maps are therefore drawn on a large or small scale according as the area shown is small or large. Some of the earliest maps were highly pictorial, aiming at representing the ideas gathered by a very rough sketch or picture. There were no scales, and there was no accuracy regarding relative positions or size.

Better maps were prepared by the Egyptians for general purposes, and more particularly for demarcating land boundaries, though these were still rather rough sketches and represented small areas of surface only. Maps of larger areas, to show the whole of the then known world, were first prepared by the Greeks ; and as the land areas then known covered a greater distance east to west than north to south, the east-west distance was regarded as the length (longitude) while the distance north to south was regarded as the breadth (latitude).

Scales. Maps are now drawn on many different scales. When plans are drawn for house building, 1 inch on the plan may represent as small a distance as 10 feet, while in maps representing the whole world, 1 inch may show a distance of 1,000 miles. The scales generally used in the survey maps of Great Britain are ½ inch, 1 inch, and 6 inches to 1 mile. The maps published by the Survey of India are 1 inch and ½ inch to a mile and smaller scales. Larger scales are used for detailed study, particularly for towns.

It is usual to represent the scale of a map by the ratio of the distance between two points on the map to the actual distance between them on level ground. Thus the scale on a 1-inch map is shown by the representative fraction $\frac{1}{63,360}$ or the ratio 1 : 63,360, there being 63,360 inches in a mile.

Different kinds of maps. The details that can be usefully shown in maps are so many and so varied that, even in the large-scale maps, it is undesirable to crowd them together. Different maps are therefore drawn to show different types of detail. Thus, **orographical maps** show the surface features: the coast-line, and the mountain and river systems. **Geological maps** show the surface rocks or the soils over them. **Climatic maps** show temperature conditions in the area included therein, with the annual, summer and winter isotherms, pressure with isobars, rainfall with isohyets, the winds, regular, seasonal and variable, humidity and so forth. **Biological maps** present the distribution of plants, animals, and men within the area; **political maps** show the frontiers, towns, and railways; while **economic maps** represent the varying data of production, trade, and transport, and population densities and movements. Most of the details in one type of map have a marked correlation with those in another; and a comparative study of these different types of maps brings out the causal relationships between the various distributions, such as rainfall and vegetation, relief and railroads, temperature and crops. As the basic static conditions are those represented in orographical maps, the basic dynamic conditions those represented in political maps, and the fundamental pursuits of man are the economic progress and development of regions, it is always desirable to use all other maps of a region, particularly the economic maps, in conjunction with a good orographical and a good political map of the region under study.

Methods of showing relief on maps. Various methods are employed to represent the surface of the earth by maps. Ordinary maps are flat, and it is difficult to show on them what is called **relief,** i.e. the general nature of the ground as regards altitude. Models form the best means of representing a country and indicating the general distribution of highlands and lowlands therein. These are what we know as **relief models,** on which the surface is actually raised to represent irregularities of the land surface. The small size of such maps, however, makes it necessary to exaggerate the vertical scale, in which, for example, one inch may represent 1,000 feet, while in the horizontal scale one inch may represent 10,000 or even 20,000

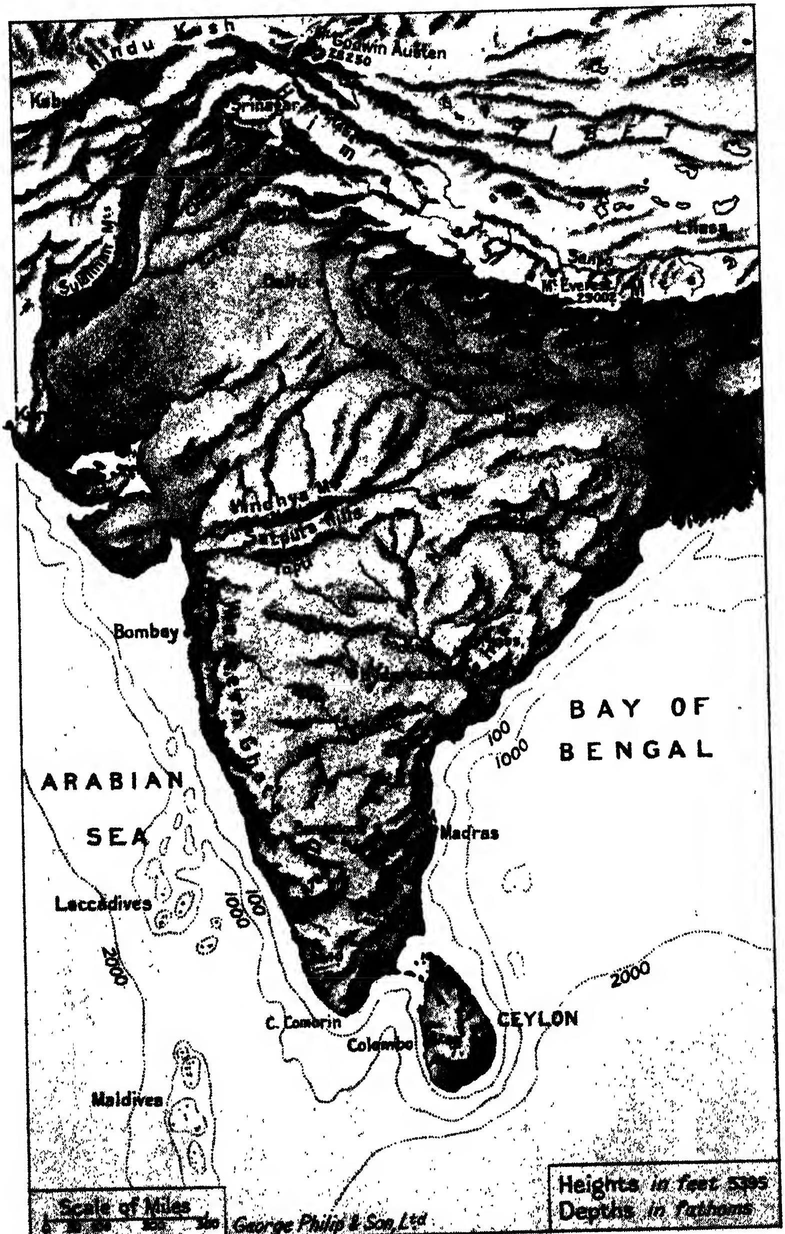

FIG. 11. Relief map of India

feet. Care should therefore be taken to appreciate this exaggeration while using such maps. The great expense of making relief models prevents their extensive use in schools and colleges, and we have often to be content with photographs of such models.

Such photo-relief maps show differences in levels by light and shade of varying degrees of intensity.

A simpler method for small areas is adopted in what are called **hachure maps.** The relief in such maps is brought out by shading, through the use of hachures or lines drawn more or less closely together and all pointing in the direction of the slope; the steeper the gradient, the closer is the hachuring. Such a map is very graphic and exceedingly useful in a study of the general form of the land, though its usefulness suffers somewhat from the fact that, though it indicates differences in slope of adjoining regions, it does not tell us the actual elevation.

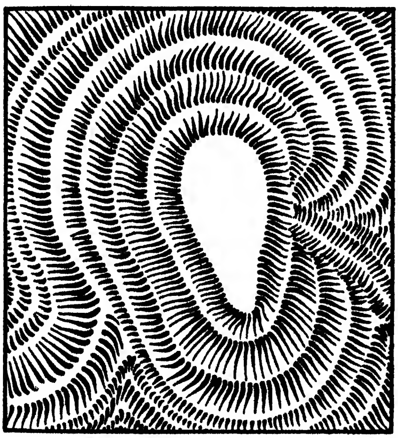

FIG 12 Hachuring

A more accurate method is to draw **contour lines** to show what the country is like at different altitudes. These lines are lines passing through places of equal elevation. The vertical distance between the contours is called the **vertical interval,** and the horizontal distance is called the **horizontal equivalent.** If we think of a beach at low tide, such as the Chowpatty sands or the Juhu beach at Bombay, the water marks a contour line—the 0° feet contour. When the tide rises say five feet, the water marks a new contour, five feet above the other. This is the five foot contour. An idea of contours may also be obtained if we take an ordinary bucket and suspend it inverted to a depth of one inch in a vessel containing water. The level of the water outside marks the contour of one inch on the bucket. If water is now poured into the vessel until it rises to 2, 3, 4, 5 inches successively, it will mark on the bucket the contours of 2, 3, 4, 5 inches. Five contour lines are thus obtained which may be represented as a plan on paper as shown in Fig. 13. The contours are in this case concentric circles, the higher falling within the lower, as the bucket is conical in shape. Most hills narrow upwards, and though very irregular, are often somewhat conical in shape too. The higher contours of such hills also will, therefore, fall within the lower ones when transferred to paper in the form of a plan, though the contours are usually of a somewhat irregular shape. The concave contours (Fig. 14), looking from *P* to *R* show a valley, down which a stream flows. It will be obvious that the closer the contours, the steeper is the slope or gradient. Plains have few contours, and they are far apart; gorges have many and they lie close together; rounded hills have contours of shapes different from those of steep-sided hills. Thus contour maps do not express relief so graphically as hachure maps, but with a little study we learn to interpret quickly from them the configuration of the land.

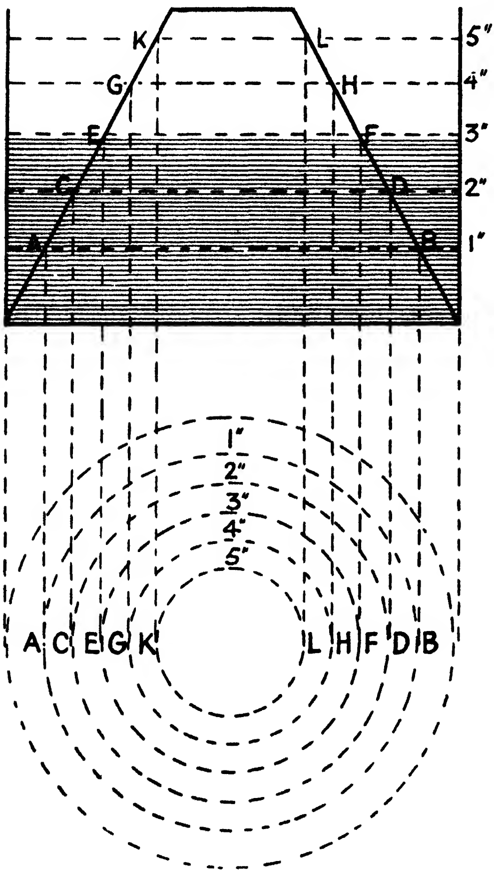

FIG. 13. Contouring

The surface features, however, can be made more graphic by drawing sections from one selected point on the surface to another. If contour lines have been drawn for an area for

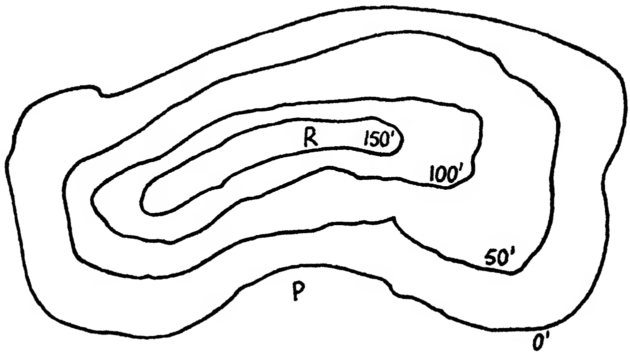

FIG. 14 Irregular contours

every 100 feet of vertical distance, and if a section is to be drawn along AB, a horizontal line $A'B'$ is drawn on squared paper to correspond to AB. A suitable horizontal scale, say in miles,

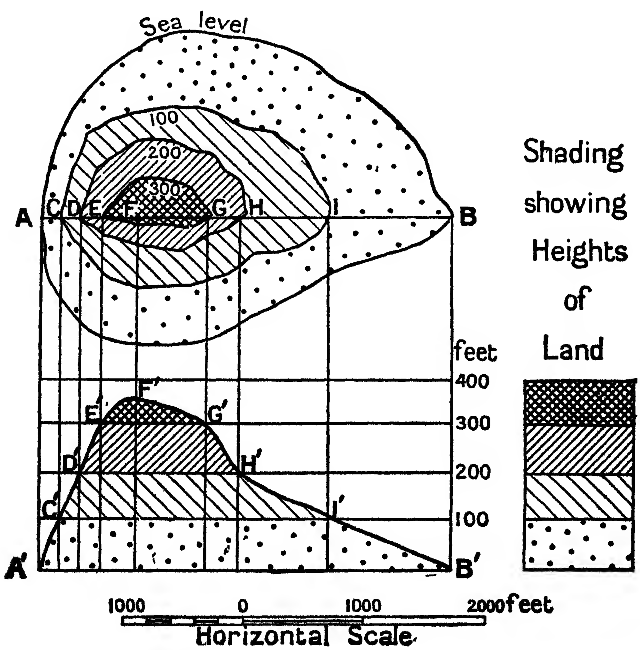

FIG. 15. Drawing a section

and a vertical scale in feet are marked; and the various points A', C', D', E', F', G', H', I', B' are plotted on the paper. The points are joined and the graph is smoothed.

Corresponding to contours on land, we have **iso-baths**—lines of equal depths—to show the relief of the sea-bed. A map with these is called a **bathymetrical map.** Fig. 16 shows a section

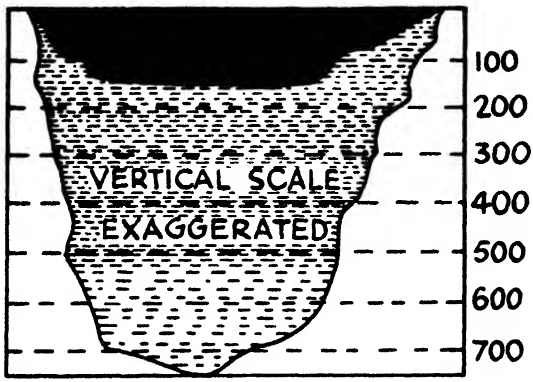

FIG. 16 Section of Loch Ness. (Scale 3 miles to an inch)

The black part shows the section on the same horizontal and vertical scales

of a portion of Loch Ness in Scotland, the black part of the figure being the section on the same horizontal and vertical scales, the lightly shaded part being the one with the vertical scale, showing the depths, much exaggerated. This exaggeration gives us a much better idea of the shape of the bed of the lake.

Important contour lines for maps. In some survey maps, the vertical interval is 20 feet; in sparsely settled or mountainous regions, a contour interval of 100 feet is often chosen. In small scale maps of large areas, countries and continents, shown in atlases, it is usual to show only selected contours to express the relief of the land. The sea level is of course shown by the coast line; the contour of 600 feet is often selected to indicate the limit of low-lying plains, and that of 10,000 feet to indicate very high mountain regions. Between them, one, two or three altitudes, as may be necessary, are selected to show the uplands, the high lands and mountain regions, the contours often selected being those for 1,000, 2,000

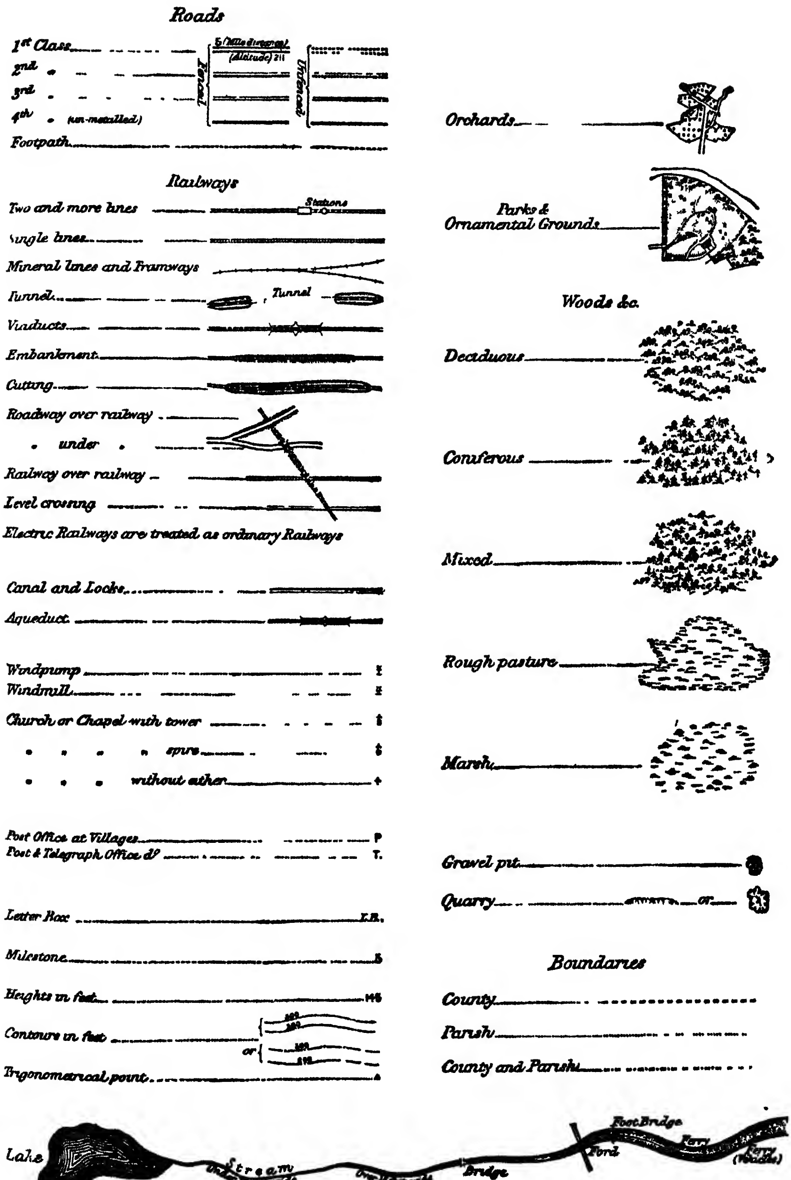

FIG 17 Conventional signs in maps

Reproduced from the O.S. sheet by permission of the Controller of H.M. Stationery Office and 5,000 feet. The iso-bath of 600 feet or 100 fathoms is similarly important in bathymetrical maps as showing the general limit of the continental shelf or submarine platform on which the land masses of the Earth stand.

Usually in atlases and maps, a **colour scheme** is also adopted to bring out more graphically the chief features of the relief of the land and depths of water. Light blue shows the continental shelf, shallow lakes and broad rivers ; a little deeper tint, the seas and oceans and deeper lakes ; green shows the river and coastal plains between the contours of 0 feet and 600 feet ; light green the area between 600 and 1,000 feet ; different shades of brown from light to dark are used for areas between the contours of 1,000 and 10,000 feet and very dark brown or purple for regions above 10,000 feet. The colour-scheme here referred to is a very common one, but is not universal, as different map-makers adopt other conventional colours.

Conventional signs. Maps are designed to give information about very many different things, besides the heights and depths of the land surface ; but the size of the available sheet and the need for clearness make it necessary for the map-maker to adopt certain signs and symbols for the representation of different features. These conventional signs enable us to understand and read the maps clearly. They are usually shown in a corner of the map for facility of reference, and it is very desirable that one should make oneself familiar with those in general use (Fig. 17).

Surveying. When it is desired to prepare a map or record of the chief physical features of a part of a country, it is necessary to make surveys. The methods generally in use for surveying are **chain surveys, traverses, triangulation** and **astronomical observations.** Simple surveying usually forms part of practical geography, but a short explanation of the methods and instruments used is considered desirable here.

Chain surveys. For surveying a small area, all that is required is a chain, a few arrows, and a measuring rod or tape.

Suppose that the plot shown in Fig. 18 is to be surveyed. The surveyor selects three stations, *A*, *B* and *C*, so as to obtain as large a triangle as is possible while having each side lying close to some boundary or other feature, as clear of obstruction as possible. *ABC* is then the main triangle. Having marked *A*, *B* and *C* by sticks or otherwise, the surveyor gets into line with *A* and *C* and fixes the point *D* in *AC* produced. He then fixes a point *F* so that *DF* runs close to the boundary; *E* is then chosen on the line *BC*, so that *FE* lies near to the boundary on that side. If the different lines are measured,

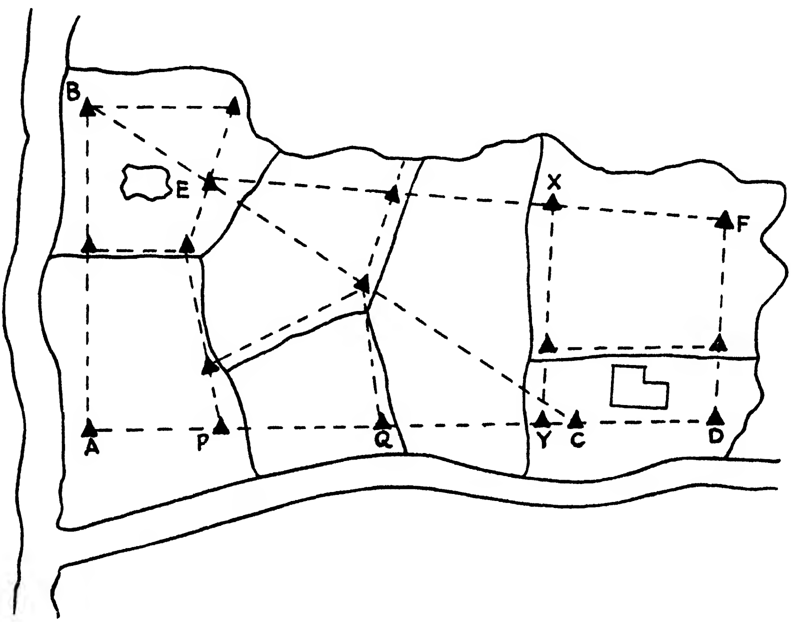

FIG. 18. Surveying by chain and tape

it is easy to prepare a plan. A scale must be chosen and the line *ACD* must be drawn to scale on the paper. *B* is obtained as it is the point of intersection of the circles with centres *A* and *C* with radii (to scale) equal to *AB* and *CB* respectively. The main triangle *ABC* is now fixed on paper. The distance *BE* having been measured, the position of *E* is determined. *F* is now obtained at the intersection of the circles with centres *E* and *D* with radii (to scale) equal to *EF* and *DF* respectively. If stations *X* and *Y* are selected in *EF* and *AC* respectively, so that *XY* lies close to a fence all the way, the length of *XY* on paper must correspond to the actual distance between stations X and Y as measured on the ground and reduced to the selected scale. Lines like XY are known as **check lines,** as they enable us to check our calculations and drawings. $ABEFDC$ is thus arranged and the measurement started. While measuring along, say, AD, points like P, Q and Y, where there are fences or other peculiar features, are selected and marked on the ground, and their distances along AD are noted in the **field-book.**

The chain used for measurement work is usually 66 feet in length. It is divided into 100 '**links**', and each tenth link is marked by a brass tag, to make counting easier. The chief chainman, the leader, starts from A along the direction AD holding one end of the chain; while the second chainman, the assistant, holds the other end exactly over A and keeps the leader in line with the rod at the other end, D of the line, by directing him to move to the right or left as he proceeds. The chain is pulled straight and tight and a pointed piece of iron, an arrow, is driven in to mark the end of the chain. Any subsidiary measurements that may be needed on that chain length, such as AP, AQ, AY are made and entered in the book. The assistant now advances to the arrow, while the leader takes the chain on for the next length; and the process is continued till the end D is reached. To fix the boundaries, the position of points like P, Q and Y having been determined, **offsets** or perpendicular distances from them to the boundaries, are measured by tape line or a graduated rod. The chain distance and offset at each such point are then read off and entered in the field-book as in Fig. 19.

In this manner, by chain surveys, we can obtain a map or plan to scale of a plot of ground. The map or plan is, however, not complete unless the direction of the north and south points is shown thereon. This direction may be obtained by compass. A line running due north and south by compass is laid out on the ground and then surveyed, as part of the survey. Allowance for magnetic declination obtained from admiralty charts must then be made to obtain the true north-south line. We can also obtain the north-south line, if we mark on the ground the direction of the shadow, exactly at noon, of any vertical line such as a vertical rod or post, as the line bisecting the dark part of the shadow to the foot of the rod will give the true north-south direction. Of course, the noon time must be properly determined and corrections must be made for the longitude and for the **equation of time.** The

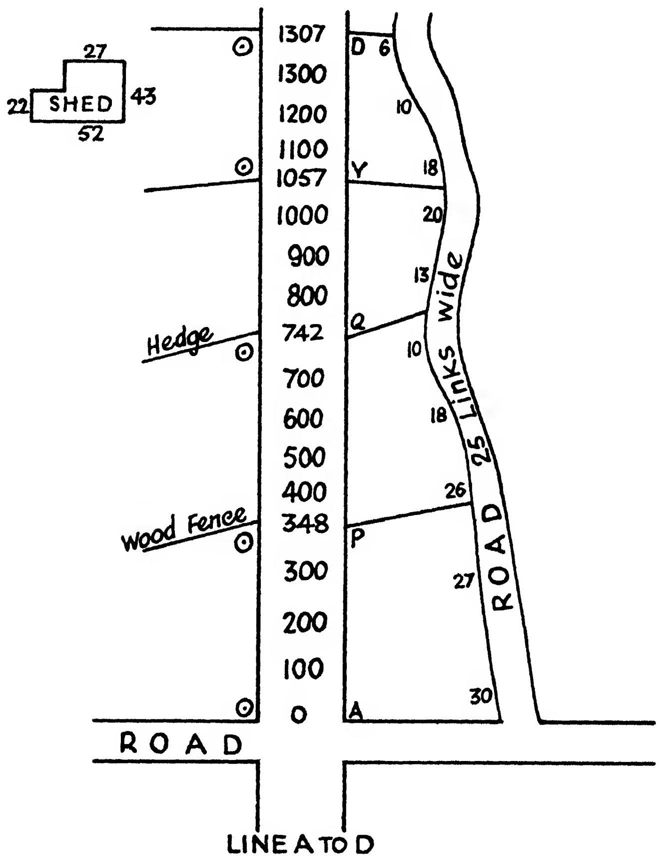

FIG. 19. Field-book entry

figures for these can be obtained from **Whitaker's** or the **Nautical Almanac.**

Compass traverses. The main objects of a **traverse** are to obtain a series of connected straight lines making various angles with each other, the lengths of the lines and the angles being determined by measurement with certain instruments. When the chain only is used as in the case of small areas, we have a chain traverse. A compass traverse, however, needs the use of the **prismatic compass,** which consists of a small bar magnet swinging horizontally and carrying a graduated ring. At one side of the compass box, there is a prism which enables an observer looking through a fine vertical slit above it to

FIG. 20 Prismatic compass

read the graduated ring. On the opposite side, there is a sighting-vane, carrying a fine vertical hair or wire.

For a **traverse survey,** we select stations as before, but we now determine the **direction** or **bearing** of each line with the aid of the prismatic compass. The lines, therefore, need not form sides of triangles as in chain surveys ; and traversing is particularly useful when we have to make a survey along a road or a railway, or along a river or a coast-line. A big area cannot be covered by a single main triangle, and in such a case, greater accuracy will be obtained than is possible in a chain survey, by a series of careful traverses, closing back to the starting point. The distances are measured as before by chain, and offsets taken. For very accurate work, the measurement of angles is done with a **theodolite** ; but good results can generally be obtained with the compass by setting up at every station, and reading all bearings, both forwards and backwards. A base-line is sometimes chosen on the area to be surveyed, and is carefully measured ; the bearing of this line is read at one end, as also the bearings to several other points in the area. A careful sketch map of the area is then prepared, on which are shown the positions of the points observed and how they are joined up. This method, known as the **compass sketch survey,** although it yields considerably less accuracy in details than a theodolite survey, is useful for rapid surveying. It may be combined usefully with a traverse, while traverse surveys are combined usefully with chain work

Plane-table surveying. The plane-table is essentially a portable drawing-board, supported on a tripod, and has a pair of flap-sights like those of the prismatic compass. An arrangement on the tripod head for clamping, levelling screws and a spirit-level on the board enable it to be turned in any desired direction, levelled and locked. The flap-sights are at the ends of a strong flat ruler, the **alidade,** which is not fixed on the board, but is simply placed upon it, and can therefore be turned to point in any desired direction without disturbing or moving the board.

FIG. 21. Plane-table

The method of plane-tabling is much the same as that of compass traversing. But here the direction of the rays in the field is drawn directly on the plane-table, instead of their bearings being measured and afterwards plotted. A base-line is chosen, measured and drawn to scale on the paper attached to the board. Suppose *ab* represents the base-line *AB* (Fig. 22). The table is set up at *A*, one end of the base *AB* with *a* on the paper exactly over *A* in the field and *ab* pointing roughly towards *B*. The board is now levelled and the alidade is so placed that its ruling edge falls exactly along *ab*. The board is now **oriented,** that is, turned so that the sights are set on *B*, the other end of the base-line. Keeping one end on *A*, the alidade is now turned, and the stations *C*, *D*, *E*, *F* which are to be fixed are sighted, and the rays to them are drawn by lines on the paper. A sketch map of the ground is then drawn to show the position of each station for easy and quick identification. If we now carry on the whole process again from station *B* as in compass sketch surveys, we can determine the position of the different stations by the intersection of the rays from stations *A* and *B*. The points then are joined up to give us the map.

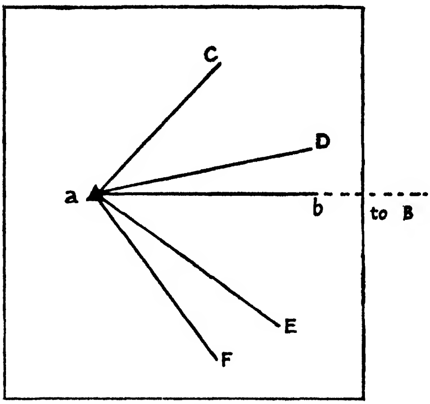

FIG. 22. Plane-tabling

Plane-tabling has advantages in that the work can be carried out much better on the ground itself with the actual objects within our sight than from a rough sketch as in the other cases, and that the map and the ground can be seen and understood in their proper relation and setting. Plane-table surveys are usually made between **triangulation stations** whose positions have been accurately ascertained by theodolite surveys. These stations are a mile or two apart, so that if careful plane-tabling is done, the error is not likely to be of any significance.

Determination of heights. When we want to determinate heights for maps or plans, and contouring has to be done, the use of rather expensive instruments becomes necessary. One of the simplest of these is the **clinometer**, which is an instrument for measuring vertical angles with reasonable accuracy, and is particularly useful for measurement over short distances. The **Abney level** is a well-known type of clinometer. It has a telescopic tube open at one end, with an aperture A at the

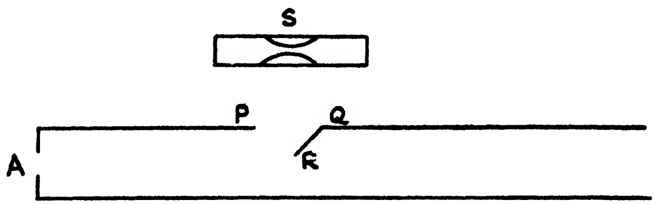

FIG 23. Abney level and clinometer

other end for sighting, and an opening PQ at the top of the tube. A small plane mirror, QR, is fitted just inside this opening at an angle of 45°. Just above the opening PQ, a spirit-level S is fixed and this can be moved by a milled knob.

The observer looks through the telescope at the point whose angle of elevation or depression is required. The spirit-level is then turned by means of the milled head and brought to the horizontal position. The angle of the slope can then be read off on a graduated circle or protractor by the index or the vernier fitted to the telescopic tube.

From the observed angle of slope $x°$, the relations between the horizontal equivalent (H.E.) and the vertical interval (V.I.) can be found either by drawing to scale or by the aid of trigonometry. But where the angle of slope is not very large, the following proportion roughly gives the relationship between H.E. and V.I.

$$\frac{\text{H.E.}}{\text{V.I.}} = \frac{360°}{2\pi x°} = \frac{360}{6\cdot2832 \times x} = \frac{57\cdot3}{x}$$

It is customary, however, to measure the V.I. in feet and the H.E. in yards. In this case, the relation between them becomes $\frac{19\cdot1}{x}$ or roughly $\frac{20}{x}$; and if the H.E. is known, the V.I. is easily obtained for most practical purposes.

The Indian clinometer (Fig. 24) enables very accurate contouring to be done. It is similar to a plane-table alidade. At one end, there is a small sight A; at the other end there

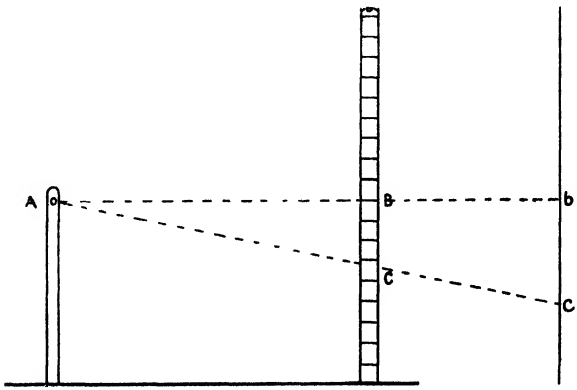

FIG. 24 Indian clinometer

is a vertical scale with zero marked at B on a level with the sight hole A, and with graduations up and down, marking tangents of the angles, that is, the value of $\frac{BC}{AB}$, that is, $\frac{\text{V.I.}}{\text{H.E.}}$. If we look at a distant point C and read 0·2 at C on the scale, we learn that the fall from B to C is 0·2 of the H.E. which can be measured.

Besides these, there are many other methods in surveying of finding heights or levels, but these need not be explained here. The use for this purpose of the **barometer** and the **hypsometer,** or the boiling point thermometer, is well known, but gives only very rough results.

Triangulation. In compass traverses and chain surveys the most important part of the work consists of the measurement of distances. But the rough and irregular character of the ground makes it difficult to take accurate measurements of horizontal distances. Further, temperature and the amount of stretch applied affect the lengths of the measuring instruments themselves. Again, one cannot be quite sure that in chain measurement the next chain begins at the exact point where the previous one ended. When, therefore, the distances over which such surveys are carried are fairly large, errors accumulate, and these are further increased by errors in drawing. Even with all care, no high degree of accuracy can be attained in fixing directions, so that as the survey proceeds, errors go on accumulating. It is therefore very necessary that when the area to be surveyed is fairly large, a number of points should be fixed as accurately as possible, by means of a triangulation survey. With these points, we can check detailed surveys and adjust small errors.

Triangulation consists in taking the bearings of various objects from the ends of a carefully selected and measured base-line, and then building up a number of triangles. Such an interlacing polygon is shown on Fig. 25. In the polygon *ABCDE*, the vertices are joined to a **centre station** *O*.

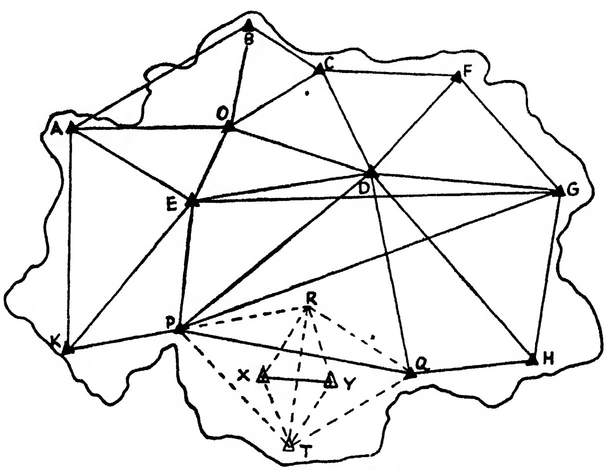

FIG. 25. Interlacing polygons

D is now taken as the centre station of another polygon and so on. We select one of the sides of the polygon as a base-line, and measure it directly if it lies on more or less level ground without any conspicuous obstacles. If such a line cannot be selected on account of the unevenness of the ground, we measure a shorter base on even ground close by. Thus if *PQ* is selected as the base-line, and *XY* as the shorter base, we carefully measure *XY* and build up triangles *XYR* and *XYT*, so that the base *PQ* can be calculated from the measured length of *XY*. The angles of the triangles are measured very carefully by means of a **theodolite,** and are tested and adjusted, particularly in the case of big triangles, where we must make allowance for the **spherical excess** on account of the curvature of the Earth's surface. The sides of the triangles can now be calculated from the angles and from the measured base. To check the results obtained, other base-lines, **bases of verification,** may be selected in different parts of the area to be surveyed, so that their lengths, as measured, will enable us to check the lengths as calculated.

From **astronomical observations,** the latitudes and longitudes of a few stations are determined ; these will enable us to work out the latitudes and longitudes of other stations, so that each station can be plotted directly on the paper. Detailed surveys start from one or more of these stations and close exactly on to the other stations, with adjustments if necessary.

7. MAP PROJECTIONS

The best representation of the Earth's surface is of course a **model** of the Earth suitably reduced in scale. Such a model, the **reduced Earth,** is an ordinary geographic globe. But such globes are not convenient for ordinary use and a flat map is desirable. If, therefore, parallels of latitude and the meridians of longitude could be transferred from the spherical globe to a flat sheet of paper, the triangulation stations whose latitudes and longitudes have been determined can be plotted and the map of the surveyed area can be drawn. How to transfer these parallels and meridians from the curved surface of the globe to the flat paper, how to lay down the map-net as nearly as possible as they are on a globe, is the problem ; and any definite system of such transfer and laying down of the map-net on flat paper is called a **map projection.**

It has not been found possible to devise any perfect method for this purpose, with the result that the maps drawn on any system of projection are in some way and to some extent distorted. The distortion varies with the size of the area mapped. It is greatest when the map attempts to show the whole world, but it is small when only a small country or a province is concerned. Many systems of map projections have been devised, each one claiming superiority over the rest in some particular, and each one having a defect of its own in another respect.

A good map projection should show correct shape, correct area and correct relative position. It has not, however, been found possible to secure all these three qualities in any system of map-projection ; one or more qualities are emphasized, others neglected. Projections are therefore classified broadly as follows: equal-area projection, accurate in area; equiangular or orthomorphic projection, accurate in shape; and equidistant projection, accurate in distance and relative position. Projections are also classified, according to the methods used, as **cylindrical, conical, zenithal** and others, and it is the combinations of these method and quality classes that give us the different types of map projections in use, such as cylindrical, equal-area, zenithal, orthomorphic and so on.

Cylindrical projections. In these projections, the reduced Earth is assumed to be enclosed in a cylinder of paper just touching it at the equator, and the parallels and meridians are transferred from the sphere to the cylinder by tracing, or in various other ways. When the cylinder is unfolded, the equator appears as a horizontal straight line ; the parallels of latitude, which are complete circles on the cylinder, become, on unfolding, straight lines equal and parallel to the equator. The meridians of longitude appear as parallel lines perpendicular to the equator, the distance between them at all latitudes appearing therefore to be the same as at the equator. The scale of the map thus increases as we proceed from the equator towards the poles, so that the two poles, instead of being represented as points, become straight lines parallel to and as long as the equator.

The best known of cylindrical projections is the one known as **Mercator's projection.** This projection is **orthomorphic.** To preserve true proportions, the scales at any one point of the map have to be kept the same along the meridian and along the parallels, and meridians and parallels must meet at right angles everywhere. The scale along the meridian at each point is therefore increased inasmuch as it is stretched along the parallel. The cylindrical projection doubles the latitude scale at 60° ; in Mercator's projection therefore the meridian scale is doubled, with the result that an area of 1 square mile will, at latitude 60°, appear grossly exaggerated as an area of 4 square miles. Equal stretching north to south and east to west preserves the correct shape of the areas mapped and straight lines on the map are lines of constant bearing, **rhumb lines.** Mercator's projection thus gives us a map true for shape and direction. But areas are more and more grossly exaggerated as we approach the higher latitudes. Greenland,

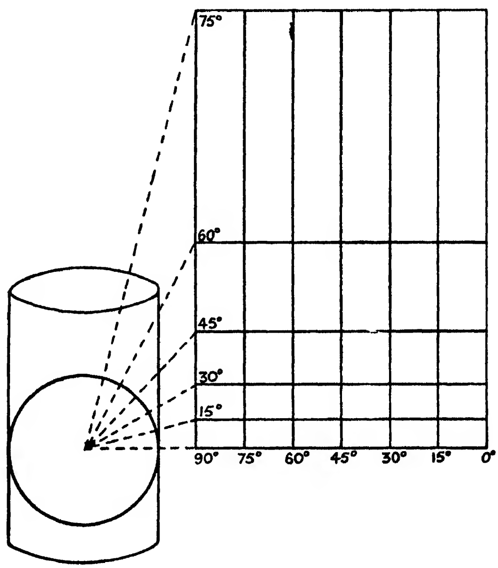

FIG. 26. Mercator's projection

really less than one-twelfth of South America, appears on this map somewhat larger than that continent. Alaska, about one-fifth of the United States of America, appears almost as large. The projection is, however, useful for navigation on the sea and in the air. It is also useful for charts of winds, ocean currents and generally in all cases where true directions are required.

Sometimes an idea of projections is sought to be given by imagining a small electric light bulb placed at the centre of a hollow and transparent sphere on which the lines of latitude and longitude are shown as black lines, or of a framework of parallels and meridians; and by projecting these lines as shadows to the paper—a plane, cylinder or cone, touching the sphere or framework. Such a method is, however, of but little practical value, since it gives no true projection, zenithal, cylindrical or conical.

Cylindrical projections exaggerate the scale along the parallels. The **Sanson-Flamsteed** or **sinusoidal projection** is therefore designed (Fig. 27) as a modified cylindrical projection, to do away with this exaggeration and to ensure correct areas

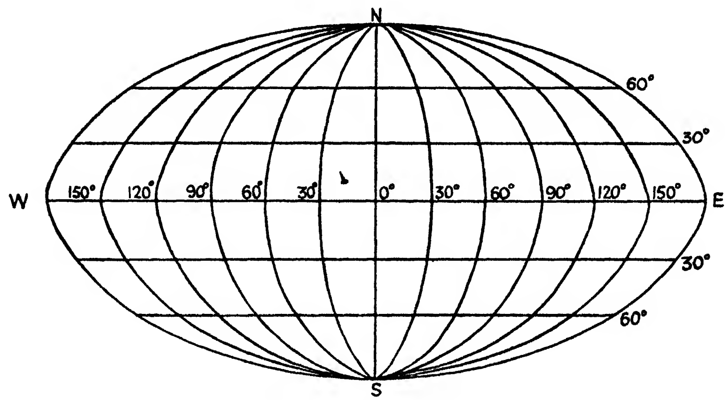

FIG. 27. Sinusoidal projection

by making each parallel correspond with its true length on the globe. The parallels are divided on either side of the central meridian, which is half the equator, into eighteen equal parts to represent 10° each. The parallels are at equal distances along the central meridian. The meridians are therefore curves through the points of division. We thus get an equal-area projection very suitable for statistical maps. It is, however, not orthomorphic and the distortion of shape becomes more marked as we depart from the equator and central meridian. This projection is suitable for a country or continent which does not extend too far north or south of the equator, nor too far east and west of the central meridian. It is therefore very suitable for Africa and South America, and is often used for these continents.

Conical projections. Cylindrical projections are satisfactory for equatorial regions, but the distortions assume importance as we go north or south. Conical projections attempt to avoid the defects of the cylindrical without bringing in those of the sinusoidal. In the **simple conical,** a cone of tracing paper is fitted over the reduced Earth, so as to have its apex on the produced axis of the globe and to touch it along some chosen parallel, usually the one which is central for the area to be mapped, and which is called the **standard parallel.** The network of parallels and meridians can be obtained if we draw straight lines from the centre of the globe, through sufficient points on its surface to the cone. The meridian scale on this net is correct and the meridians meet the parallels at right angles. The pole on this map-net becomes an arc of a circle, and not a point. The meridians are straight lines converging to the vertex of the cone and the parallels are arcs of concentric circles with the vertex as centre. It must be realized, however, that this projection gives us a map which is neither equal-area nor orthomorphic, there being distortion north to south, which becomes greater the farther we go from the standard parallel. The map will only be fairly correct for a country which has no wide range of latitude. To overcome the defects of the simple conical, **Bonne's projection** has been derived as a **modified conical** (exactly as the sinusoidal is derived from the simple cylindrical) so that it becomes an equal-area projection. A wide range of latitude does not matter,

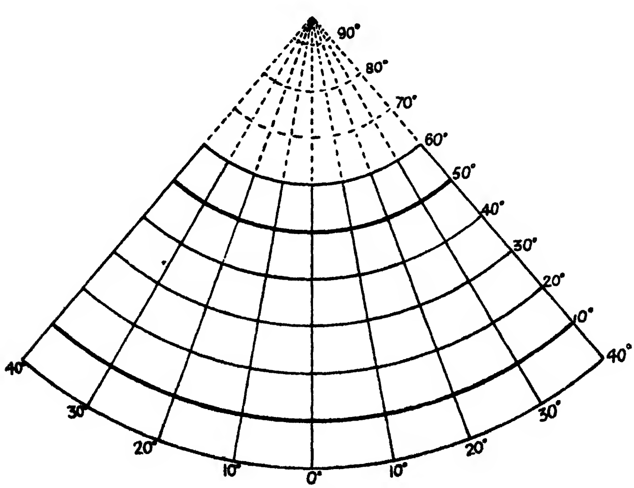

FIG. 28. Conical projection

but a wide range of longitude introduces distortion. The Bonne is commonly adopted in British atlases.

The simple conical can, however, be greatly improved by making two standard parallels correct to scale. These are usually so chosen that they are about one-sixth the extent in latitude of the area to be mapped from the top and bottom. This projection is more orthomorphic and more equal-area than the simple conical, and is therefore a good average projection ; and a conical projection with one or two standards may, by the aid of suitable methods, be converted into an equal-area projection or into a conical orthomorphic. Conical projections are further modified, so that independent maps of areas north and south as well as those of areas east and west of one another shall fit together ; such a projection is known as the **polyconic.** It is not necessary, however, to enter here into a detailed description of the methods used in their construction. The polyconic suffers from two defects : one is that distance between meridians increases the more east or west we go from the central meridian ; and the other is that, the meridians being curves, the maps of areas east and west of one another will not fit together well. In the **international conical** therefore the polyconic is somewhat modified. The meridian distances are made accurate along meridians two degrees on each side of the central one, so as to reduce the east to west stretching ; only those parallels at the top and the bottom are divided correctly, and the straight lines joining these points of division are regarded as the meridians, so that the sheets will now fit together properly. This projection is adopted for a map of the whole world now under publication in different countries in separate sheets, on a uniform scale of 1 : 1,000,000, that is, 1 mm. to 1 km. or about 16 miles to the inch, each sheet covering 6° of longitude and 4° of latitude.

Zenithal projections. These projections have the network drawn directly on a sheet of paper supposed to touch the reduced earth at the centre of the map. Great circles through this point become projected as divergent rays through the centre of the map at true angles to each other. Zenithal projections are therefore '**azimuthal**' since they give the true bearings or azimuths of points from the centre. These projections are usually **polar** ; that is, the pole is the centre of the map where the paper touches the globe, the meridians becoming a series of straight rays, and the parallels becoming a series of concentric circles about the pole. Zenithal projections can also be drawn with the tangent-plane touching the sphere at the equator or any intermediate point, when they are known respectively as equatorial and oblique zenithals.

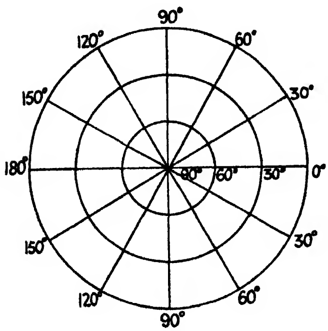

FIG. 29. Zenithal projection . equidistant—polar

In zenithal projections, the position of the point from which the graticules are projected on to the tangent-plane gives us different types. Thus, when the point is the centre of the globe, we have **zenithal stereographic**; when it is at the opposite end of the diameter from the point of contact, we have **zenithal gnomonic**; and when it is at infinity, we have **zenithal orthographic.** Of these, the stereographic projection is orthomorphic. By suitable methods, zenithal projections can also be made equal-area.

The **gnomonic** or **central projection** is neither equal-area nor orthomorphic. But every great circle, not only those that pass through the centre of the map, appears as a straight line. This projection is, therefore, very useful for great-circle sailing.

Reviewing the characteristics of the different projections, we find that while cylindrical and zenithal projections are suitable for maps showing the whole Earth, the conicals are obviously unsuitable for such maps. Mercator's and the sinusoidal are particularly useful: the former, being orthomorphic, is very suitable for navigation; the latter, being equal-area, is useful for statistical purposes, though its pointed shape at the poles reduces its usefulness. The zenithal projections are suitable for the world in hemispheres; the equidistant where correctness of the distance and direction from the centre of the map are essential; the equal-area for statistical purposes, and the gnomonic or central for great-circle sailing. The conical projections are also useful for the maps of small areas and smaller political units.

Besides these, there are three other projections which are fairly important.

The **globular projection** is a purely arbitrary projection and has no peculiar characteristics whatever. A circle is divided into four equal parts by two diameters at right angles to show the central meridian and the equator.

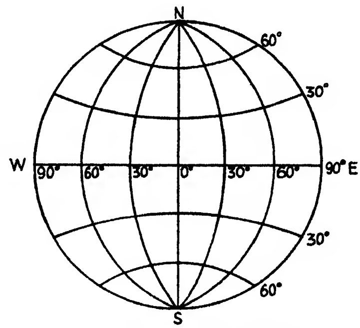

FIG. 30. Globular projection

Each quadrant and each of the four radii are divided into nine equal parts, for the meridians and parallels at 10° intervals; arcs through the points on the circle and central meridian give us the parallels, and those through the poles and the points on the equator, the meridians. A defect of this map-net is the difference in the scale of the middle of the map from that nearer the margins, though there is much less marginal distortion of shape here than in stereographic or orthographic projections. The **orthographic** has already received reference under zenithal projections. It is really much like a photograph or a picture of the globe. The projection is useful for astronomical purposes only, since it represents the Earth as viewed from a great distance. Towards the edges of the map the parallels and meridians become compressed, while the centre remains correct; and there is distortion of distances, directions, shapes and areas. An **equal-area hemispherical projection** (Lambert's) has, however, been devised, which by north to south stretching and east to west compression shows correct areas.

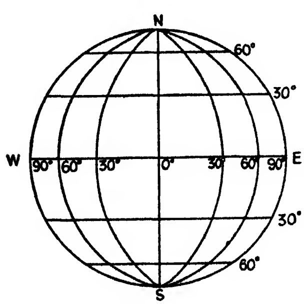

FIG. 31
Orthographic projection

Mollweide's or elliptical equal-area or homalographic projection. The sinusoidal projection is not suitable for a map of the whole world because there is a pointed shape at the poles; Mollweide's projection attempts to remove this defect, while showing correct areas. The globe is represented by an ellipse, the major axis AB being twice the minor NS which represents the central meridian. A circle on NS as diameter intersects AB at E and Q, EQ representing the equator, and the circle $NQSE$ representing half the total area of the Earth.

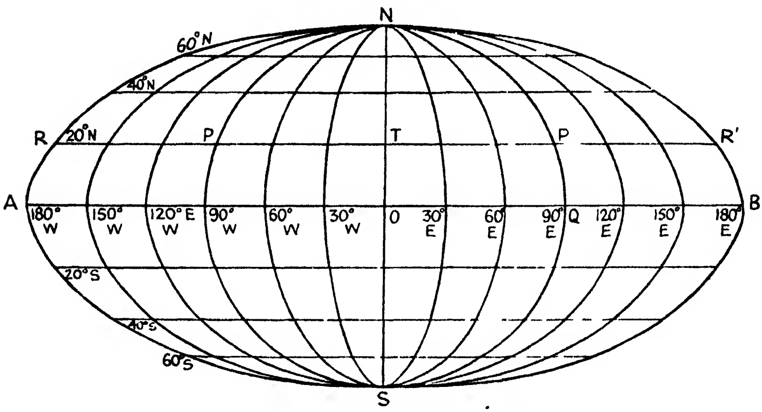

FIG. 32. Mollweide's projection

A parallel of latitude like $RPP'R'$ is drawn parallel to the equator EQ cutting the circle $NQSE$ at P and P' and the central meridian NS at T. PT and $P'T$ are divided into, say, three equal parts for meridians 30°, 60° and 90° E. and W. PR and $P'R'$ are made equal to PT and divided into three equal parts for meridians 120°, 150° and 180° E. and W. Other parallels are drawn at distances along the central meridian obtained by calculation so as to preserve the equal-area property, and divided in a similar manner. These points on the parallels are joined up to give us the meridians, all of which, except the central meridian, will be ellipses, the 180° or bounding meridian forming an ellipse of which the major axis is twice as long as the minor axis; the area enclosed is twice that of the circle $NQSE$ and therefore equal to the area of the globe. This projection shows correct areas, but distorts direction, distances and shape and, for these reasons, is not useful to sailors. It is, however, particularly suitable for statistical purposes, such as showing the distribution of rainfall, vegetation, population, empires, etc.

It may now perhaps be useful to review briefly the chief properties of the principal projections we have been describing, and tabulate the distinctive characteristics which enable us to make out what projection a particular map-net represents.

A. Meridians : straight and radiating.

(i) Parallels : 1. Concentric arcs—conical projections.
- (a) equidistant—conical, simple.
- (b) closer in the centre—conical orthomorphic.
- (c) farther apart at the centre—conical equal-area.

2. Arcs, but not concentric—polyconic projection.

(ii) Parallels : complete circles : zenithal projections.
- (a) equidistant—zenithal equidistant.
- (b) distance increasing outwards—zenithal orthomorphic.
- (c) distance decreasing outwards—zenithal equal-area.

B. Meridians : straight and parallel.

(i) Parallels : straight—cylindrical projections.
- (a) equidistant—cylindrical equidistant.
- (b) farther apart in high latitudes—orthomorphic-Mercator's.
- (c) closer together in high latitudes—equal-area.

C. Meridians : curved.

(i) Parallels : straight.
- (a) equidistant—sinusoidal projection.
- (b) farther apart nearer equator—Mollweide's projection.

(ii) Parallels : circular.

concentric—Bonne's projection.

D. Meridians : circular.

Parallels : circular and equidistant—globular projection, if a hemisphere is represented.

Chapter II

THE SURFACE OF THE EARTH

1. GENERAL FEATURES

Land and water. The Earth's surface is made up of two great divisions, land and water. Land covers only about thirty per cent, that is about one-fourth of the surface of the Earth, while water covers nearly three-fourths of it. Almost the whole of the land mass is to be found in the hemisphere which has France for its centre, while the other hemisphere, which has New Zealand for its centre, is nearly all ocean. These hemispheres are generally referred to as the land and water hemispheres. The equator divides the globe into two hemispheres—the northern and southern, the northern having about twice as much land as the southern.

The ancients had rather queer views about the surface configuration of the Earth. They thought that the surface was largely land, stretching farther from east to west than from north to south; and they placed the parts they were most familiar with in the centre of the land surface, and held that the various parts were symmetrically arranged so as to balance one another. Thus the Hindus believed in a series of seven concentric alternate belts of land and water with India in the centre; while the Greeks and Egyptians placed the Mediterranean with Delphi, and later Jerusalem, as the centre, and the 'ocean-river' round about the circumference.

We now know that the lands surround the waters in a gigantic girdle circling each of the two great oceans, stretching round the Atlantic, from Cape Horn to the Cape of Good Hope and round the Pacific from Australia to Cape Horn. Where the lands are separated by narrow straits, the waters are very shallow, suggesting the past connexion of lands now separate. The oceans, however, are a continuous sheet of water, although they are known by different names in different parts—the **Atlantic,** whose bed is supposed to have once formed a continental land mass; the **Pacific,** which is far from peaceful;

the **Indian**, over the submerged Indo-African continent; the **Arctic**; and the **Southern**, stretching round the globe, south of Cape Horn.

There is not much difference between the highest elevation on land and the greatest depth of water. The highest mountain on the Earth is Mount Everest, 29,002 feet, the conquest of which is at present the objective of exploring parties from various European countries, while the deepest abyss lies off Mindanao in the Pacific Ocean, 35,410 feet. But the average height of land is about 2,300 feet, and the average depth of the sea is 11,500 feet, that is five times the former. If, therefore, all the land of the world, ocean beds and continents alike could be spread out evenly and reduced to a common level, the world would be a vast ocean nearly two miles deep. It is only because of the uplifting of the Earth's solid crust into giant folds that there is any dry land at all. Fig. 33 shows the proportions of the main divisions of the lands and oceans, according to their position above or below sea level.

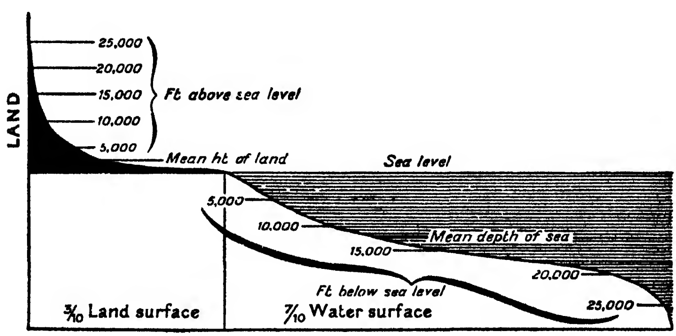

FIG 33. Hypsographic curve

If we examine a globe showing the general features of the distribution of land and water, we find that a continental mass on one side of the globe has opposed to it an ocean on the other. Thus, the north polar region is occupied by the Arctic Ocean while the south polar region is the Antarctic continent, and the chief land masses form an almost continuous belt round the Arctic, while the Antarctic land mass is surrounded by a ring of water—the Southern Ocean. Europe and Africa and a large part of Asia are opposed to the Pacific; Australia and Eastern Asia to the Atlantic ; and North America to the Indian Ocean. The land masses with the continental shelf included form three main groups, the Americas, Europe and Africa, and Asia with Australia, each of which is broad-based in the north, but tapers away rapidly in the south, so that these hardly reach half the distance from the equator to the pole in the southern hemisphere. Further, we notice a mid-world depression occupied by the inland seas. The northern continents lie mainly to the north of this depression and the southern continents to the south of it ; and a definite lateral shift has been suggested as they are placed more to the east than the corresponding northern ones.

All these facts concerning the general features of land and water distribution on the surface of the Earth are simply and well explained by the tetrahedral theory of the shape of the Earth, based upon the idea of a pear-shaped body undergoing a collapse in cooling.

Main features of land relief. The continents are surrounded by submerged land not more than 600 feet below sea level. The land is really an under-water extension of the continents, and is a platform on which the continents rest. In some cases, this **continental shelf** is very broad, and high parts arise from it above the surface of the water as islands (**continental islands**) like Ceylon and the British Isles. Where the shelf ends there is generally a sudden, rather marked increase in slope of the ocean bed which sinks to many thousands of feet below sea level. The ocean bed is by no means level, and here and there there are long deep troughs or profound abysses, while in some cases long ridges arise from the sea floor, but remain much below the surface of the water. From such

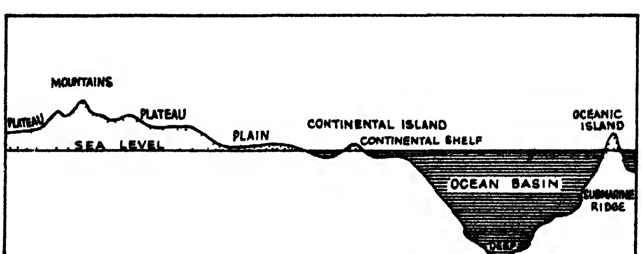

FIG. 34. Main features of land relief

ridges, **oceanic islands** are upheaved as a result of volcanic action, often far from any continent. Ascension and St. Helena, and the Andamans and Nicobars in the Bay of Bengal are examples.

The mean features of land relief may be grouped broadly into three great types.

1. **Plains.** (i) **Coastal plains** like Gujarat, the Konkan and Malabar. These may be formed either by rivers depositing the silt brought by them from their basins, by the subsidence of coastal lands or by the emergence, through uplift beyond sea level, of part of the continental shelf.

(ii) **Inland plains,** like the Indo-Gangetic plain, extending far inland, sometimes cut off from the sea by high land.

2. **Plateaux.** These are land masses rising abruptly from the plains below, and sometimes have steep edges which appear as mountain ranges to people of the lowlands. The Deccan is such a plateau with the western edge appearing as a mountain range, the Western Ghats

3. **Mountains.** These may be **fold-ranges, crust-blocks, mountains of circumdenudation** or residual mountains, and **volcanoes.**

Ocean floor. Similar forms are met with on the ocean floor, but the ocean bed generally has gentle slopes, the water covering protecting it from the forces of erosion and denudation which so powerfully sculpture the land surface. The chief forms are **continental shelf, troughs, basins, deeps, ridges,** and **submarine plateaux.**

2. CRUST MOVEMENTS

The crust of the earth. Below the soil on the land and below the bed of the ocean, there is solid rock, and it is this bed of rock which is the outer crust of the Earth, believed to be about fifty miles thick. We cannot definitely say very much about the state of the interior of the Earth. It is certain, however, that it is made of very heavy materials and that there is such intense heat that the ordinary melting-point of even the hardest and the most resistant of rocks is attained. But the melting-point of the rocks under the tremendous pressure of the outer layers rises very high. This leads us to suppose that the interior must be at a very high temperature and under very great pressure, and possibly solid. Anything tending to reduce the pressure, such as a fault causing local displacement of rock, may cause instant liquefaction of deep-seated rock, force it up through the joints and faults into overlying strata and perhaps even out from the surface as a volcano. It is a scientific fact, however, that whatever the pressure, after a certain temperature is reached, a substance will pass into the gaseous state, and that the melting-point rises only up to a certain pressure; beyond that pressure it begins to decrease. Thus there seems good reason to suppose that the earth-core is gas under enormous pressure and at tremendous temperature, so altered by pressure and temperature, that it may behave as a solid. But it is obvious that no definite conclusion can be reached regarding the state of the central portions of the Earth.

Crustal movements. The occurrence, even at the tops of mountains, of numbers of shells and the teeth and bones of marine organisms, and the presence of sea-worn pebbles and other matter usually associated with land along many sea coasts below sea level suggest that great movements have taken place in the Earth's crust. The raising of the Malabar coast from the Indian Ocean ascribed by legends to the hero Parasuram, and the sinking of the Dwarka of Shri Krishna point to these slow crustal movements. Norway and western Scotland also show subsidence of the coast-line, so that the glaciated valleys have been converted into long arms of the sea, while the higher parts remain outstanding as small islands off these lands. In the Himalayas and the Alps and other mountain ranges, beds with marine fossils are found at a height of many thousands of feet.

It is these slow upward movements of the crust that are of great importance in the building up of continents. New lands gradually appear above the sea; older lands are being slowly and steadily eroded and reduced to sea level, and in many places, the horizontal layers in quarries and mines as in other rocks have been subjected to such tremendous resistless force as to produce folds, tiltings, crumplings and extraordinary contortions.

The forces that cause these crustal movements have been accounted for in various ways; but the generally accepted theory regards them as effects of the gradual cooling of the Earth. Cooling, and the consequent contraction of the interior, aided by gravitational force and by the weight of the atmosphere, lead to the crumpling of the outer crust, giving rise to deep troughs and great folds in the crust which, where pronounced, appear as mountain ranges, and, where gentle, as a tilting of the strata. The arrangement of the world-ridges along the borders of the great oceans and between the great continental masses offers an alternative explanation, namely, that the continental masses, made of relatively lighter materials, rest on the heavy rocks below, and that the continued action of denudation and deposition upsets the equilibrium and causes uplifting, twistings and folding along the land-margins. Earth movements have also been accounted for by regarding them as caused by gravitational force in trying to readjust the crust in order to restore the balance of the rotating Earth.

Mountain formation. Mountains result from the formation of material into an elevated mass by superficial or subterranean action, or by a mass remaining upstanding on the wearing and planing down of surrounding material. Surface action piles up rock fragments and lava in volcanic areas; but mountains so formed are usually isolated and do not attain any great elevation and are not therefore of particular importance. Fujiyama in Japan, Popocatepetl in Mexico, and the Hawaiian volcanoes are good examples of this kind of mountain. The upheaval of material by subterranean action gives rise, however, to the most important mountain systems of the

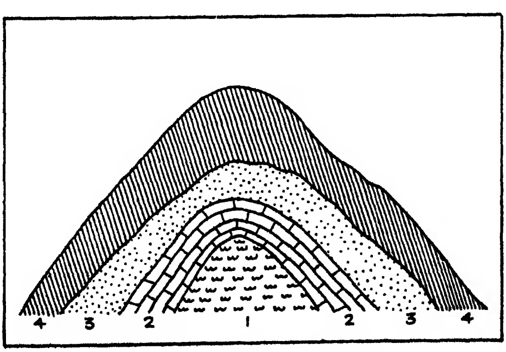

FIG. 35. Upfold or anticline

Earth, and the great **fold** mountains like the Himalayan-Alpine system have been the result of the crust crumpling into folds, twists and contortions. In most fold systems, rock sections show the strata to be not merely tilted or folded, but often curiously twisted on one another. Fig. 35 shows three great layers of rocks bent into a great **upfold** on unstratified ancient rock. Those layers which are of most recent origin appear at the surface; the oldest repose on the ancient crystalline rock. But the upfold or **anticline** will be subjected to the forces of denudation and the arch will in time wear away. In the course of ages the mass will not only lose in height, but will present an altogether changed appearance (Fig. 36). While ascending the range, we first come across the youngest

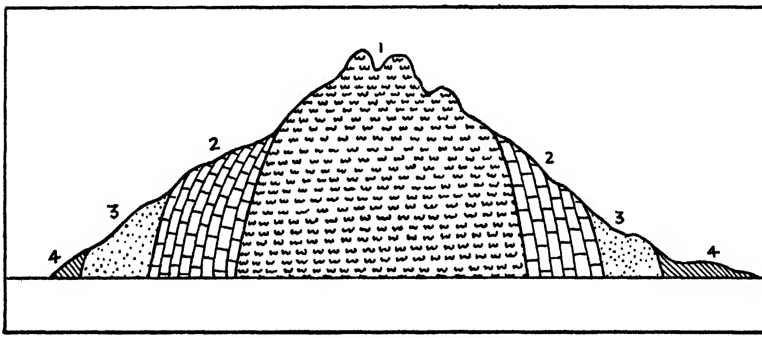

FIG. 36. Weathered anticline

series, then a series of older rocks, then a series still older, until finally at the top we come to ancient unstratified rock which would be expected to occur thousands of feet down in the interior of the Earth. Earth-movements thus expose for examination and study, older rocks which otherwise would have remained buried deep down in the interior of the Earth.

The Earth's crust is at some places rigid, and at others, relatively speaking, elastic; and the action of the internal forces fractures the rigid parts and bends or folds the elastic parts, along lines of weakness. These cracks or fractures in the crust are termed **faults** (Fig. 37). A part of the crust slips down along a fault line and causes a break in the rock strata, and it often happens that in mining operations a vein of the mineral suddenly seems to end and that further digging has to be done above or below to find its continuation. If faulting takes place over an extensive area, large crustal masses slip

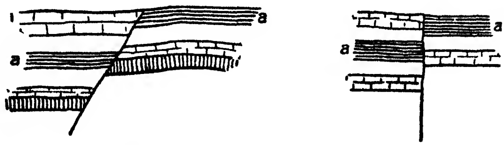

FIG. 37. Fault or fracture

down and form a basin or a long depression with steep sides (Fig. 38); such basins are termed **faulted basins** and the troughs are called **rift valleys.** Thus the Red Sea is the submerged part of a great rift valley stretching from the mountains of Lebanon to the Dead Sea and Jordan and extending southwards to the great lakes of Africa. The central lowlands of Scotland are also a good example of a broad rift valley, formed in this way.

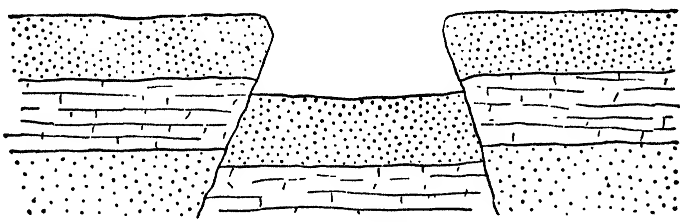

FIG. 38. Rift valleys

Where subsidence takes place along a series of faults, portions of the crust are left standing high above the surrounding level (Fig. 39). These form plateaus, whose sides rise so abruptly from the plains below that they appear to be the flanks of a mountain range. Numerous such **crust blocks** stand out as plateaux in Africa. Korea, the Spanish **meseta** and the Bohemian plateau also well illustrate the formation of plateaux in this manner, while a series of such cracks and subsidences has formed the Great Basin in North America.

Residual mountains or **mountains of circumdenudation** are formed, not by any building up process by the accumulation of material, or by upheavals and subsidences, but by the forces of erosion and denudation. River and rain may so act on ancient plateaux as to cut them up and wear them down so that they appear to be mountain ranges. The Deccan plateau is a good example of a volcanic plateau of accumulation in India, now dissected into uplands, hills, valleys and plains.

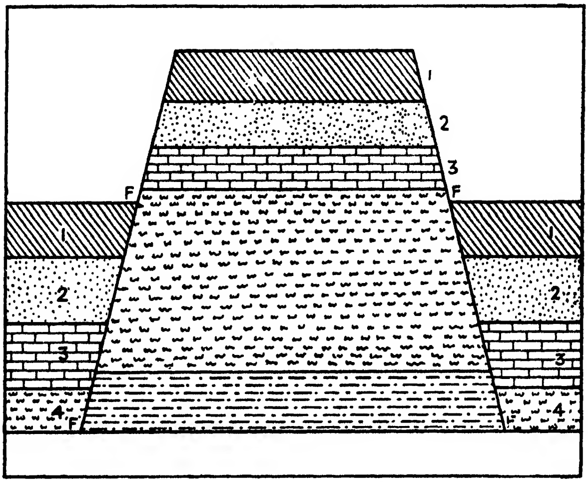

FIG. 39. Crust block

Thus there are several mountain ranges which have been formed not by the folding and crumpling of the Earth's crust, but by the dissection of a plateau. The Scottish Highlands, the Appalachians of North America and the Great Dividing Range of Australia are mountains of circumdenudation formed largely in this manner, though the rocks in all show also evidence of internal crumpling, while the Grand Cañon of Colorado shows the process of such a formation in an area where the rock beds are practically horizontal.

Earthquakes. Besides the slow movements of the Earth's crust, operating over long periods, which have been largely responsible for continued changes on the Earth's surface and the formation of mountains, there are sometimes startling movements which produce sudden and remarkable changes. Earthquakes and earth-tremors are in many cases connected with subterranean action leading to upheaval and subsidence, folding or fracturing, for the areas of greatest frequency are those where the crust is unstable or weak. They are, however, sometimes associated closely with volcanic regions, where they herald eruptions and explosions, or accompany them. It is difficult to explain exactly how earthquakes are caused, but the generally accepted view is that they occur when crustal masses in the interior subside along lines of weakness.

Some of the chief results of earthquakes are alterations of level, the opening of cracks and chasms in the ground (which sometimes quickly close up again, as happened in the bed of the Ganges in the Bihar earthquake of 1934), and the submergence of coastal lands and the formation of new coastlines. Rivers may disappear or change their courses, causing extensive floods, while existing streams may go dry and new ones appear. Such changes do not matter much in unoccupied areas; but where there is a dense population, earthquakes often prove to be disastrous catastrophes, and are attended with considerable damage, apart from the extreme discomfort and shock resulting from the swaying or falling of houses and the collapse of frail structures. In Cutch in India, the earthquake of 1819 caused the sudden sinking to a depth of 12 to 15 feet of some 2,000 square miles of land and an inrush of the sea which converted the area into an inland sea. At the same time a strip of land 600 square miles in extent rose 10 feet. The extensive damage and catastrophic destruction caused by the Japanese and other earthquakes profoundly shocked humanity; and the horrors, miseries and destruction wrought by the Bihar earthquake of 1934 and the Quetta earthquake of 1935 are still too recent and too vivid in our minds to need any detailed description.

The sudden fracture or slipping of the rock-masses which is responsible for earthquakes usually takes place at a considerable depth below the surface. The resulting disturbance is felt first at the surface immediately above, and spreads outwards in waves of shock of decreasing intensity and frequency. Careful observations of the time when the shocks are felt at different places enable us to determine the centre of disturbance (**epicentre**). The disturbance in some cases is so slight that there may be practically no indication thereof at the surface beyond a faint tremor. But with delicately adjusted seismographs we are able to detect and record the vibrations of earthquakes a great distance away.

The distribution of earthquakes is shown in Fig. 40.

Earthquakes represent merely incidents in the process of crustal readjustments and mountain-building, and their visible effects are soon countered by denudation ; but their suddenness and violence, and the disastrous damage to life and property which accompany them, make them appear much more harmful than they really are.

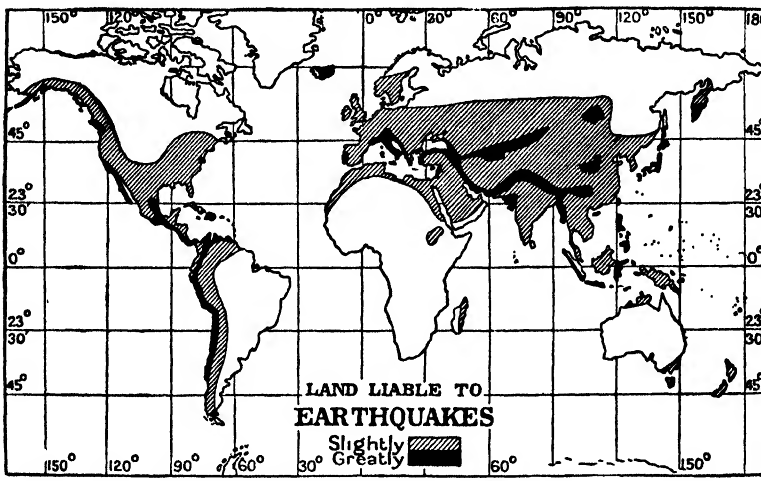

FIG. 40. Distribution of earthquakes

Volcanoes. No natural phenomenon, perhaps, strikes man's imagination, rivets his attention and excites his curiosity so much as volcanoes. They are popularly known as **jwala mukhi** (mountains with mouths emitting flames). Earthquake shocks of increasing violence are the premonitors of the terrific explosions and outbursts of volcanic matter. Large quantities of rock, fine dust and massive fragments are ejected with considerable force into the air. Steam, rising from the crater to great heights, forms dark clouds condensing in a torrential downpour. Fine ashes fall thickly and cover sea and land. The violence of the explosions within the crater goes on increasing and rock fragments are shot out with great force. The molten lava at last gushes forth over the lip of the crater and flows down the slopes, like a glowing river of molten rock and smoking slag.

It is difficult to state exactly what causes a volcanic eruption. It may, like an earthquake, be due to the changes in strain under which the weaker portions of the crust are labouring. The expansion of water percolating through cracks and fissures, when it is converted into steam, is often a cause of the outburst; but the expansion accompanying chemical changes is a contributory factor. Volcanoes are often conical, with a hollow at the top generally shaped like a funnel; the funnel is connected by a pipe or a channel with the interior seat of disturbance; the ejected materials are pushed through the pipe into the funnel, or the crater as it is called, and hurled out, and form the hill (Fig. 41). In some cases, the main pipe branches

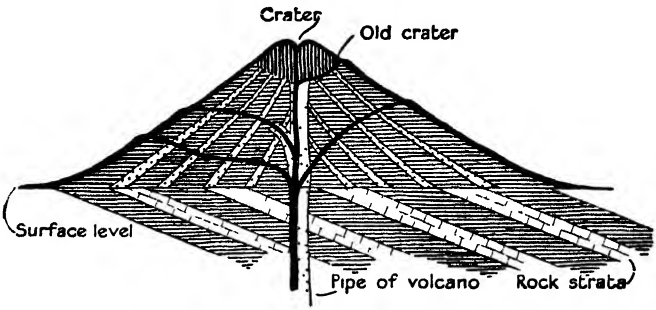

FIG. 41. Section through a volcano

out on the sides and these branches open out in smaller funnels forming secondary or minor cones with their own craters.

In contrast to explosive volcanic eruptions, there are **fissure eruptions,** where we usually have a quiet streaming out of lava, not from one or a few points, but from many points along a fissure. Such eruptions lead to floods of lava spreading over extensive areas. The most notable example of such lava formations is the Deccan Plateau of India, though the Snake River basin in the United States, and the extensive region covering the western islands of Scotland, north Ireland and Iceland are also striking cases. In the Deccan, lava covers several thousands of square miles, to a depth of several thousands of feet. The lava plateau was long ago dissected; new hills and valleys have been formed and covered with rich basaltic soil very suitable for cotton cultivation, and capable of supporting by agriculture, where well-watered by rain or irrigation, a very dense population. The eruptions in the Hawaiian Archipelago are quiet, but are not exactly fissure-eruptions. They represent an intermediate form between these and explosive volcanic outbursts.

In many places, volcanoes are continuously active and are almost ceaselessly erupting. We have near us in the Indian Ocean, to the east of the Andamans, the solitary dormant volcano known as Barren Island, which was last observed in eruption in 1789. The Andean volcanoes are still active, one of the best known being Cotopaxi. The islands in the Pacific Ocean are largely of volcanic origin and in many of them there are active volcanoes. In Europe the best known active volcanoes are Vesuvius in Italy, Etna in Sicily, Stromboli in the Lipari Islands in the Mediterranean Sea, and Hekla in Iceland. Fig. 42 shows the distribution of volcanoes, and

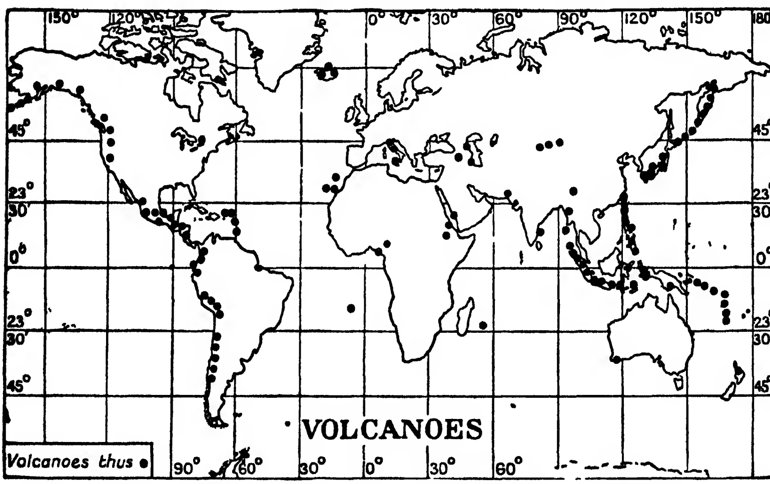

FIG 42 Distribution of volcanoes

suggests that the regions of great volcanic activity are much the same as those which are affected by frequent and intense earthquakes. One of the most devastating volcanic explosions was that of Krakatoa, between Java and Sumatra in the East Indies, in 1883. The terrific outburst was heard for a great distance, even in Ceylon, India and South Australia; a large part of the island was blown away; the volcano itself was split into two parts presenting for the first time, for investigation, a real section through a volcano. The volcanic dust was ejected to a height of many miles, and mingling with the upper currents of the atmosphere circled the globe several times.

In course of time, a volcano ceases to be active and ultimately becomes extinct. But before that happens, it passes through different stages, each marked by decreasing activity. It ceases to throw out rock fragments, lava and slag, but it continues to emit steam and various sulphurous gases which are responsible for sulphur and other mineral deposits in volcanic regions. This stage is sometimes spoken of as the **solfatara** stage. A further stage towards extinction is reached when only hot water and steam issue from the cold solidified lava of the cone, with sufficient force to form intermittent fountains, called **geysers,** reaching a height of a hundred feet or more. Iceland and New Zealand have many such geysers and the Old Faithful of the Yellowstone Park in the United States is also an excellent example. In the next stage, we notice that the flow of hot water is without any explosive force. In many regions where volcanic activity is or was well marked, such **hot springs** are fairly numerous. The Sitakund, near Monghyr, the hot springs of Vajrabai about twenty miles from Bassein near Bombay, of Unai and Arnai near Surat, of Tiwa and Tumba near Baroda, and of Manga Pir near Karachi, are familiar examples. The waters flowing out of such springs are sometimes muddy, and the deposition of mud leads to the formation of **mud volcanoes** which mark the final stage of volcanicity. Examples are found in Burma in the Ramri and Chedubba islands on the Arakan Coast, Baluchistan, New Zealand, and many other areas. The final stages are also associated with the emission of heavy poisonous gases in depressions and caverns. These gases collect near the ground and prove fatal to animals and birds.

3. MODELLING OF THE CRUST

On the vast areas of the great continental masses, we meet with extensive plains, lofty plateaux, and long mountain ranges making up the variegated surface configuration. In all of them, we find wide stretches of undulating grasslands and majestic mountain peaks, capped by ice and snow and disappearing in clouds, grand gorges, remarkable ravines, and tempestuous torrents. With the emergence of dry land above the sea level, many different forces begin forthwith to act upon it and bring about alterations in its form. Each part of the land surface has thus distinctive and characteristic scenery which is but the result of the movements of upheaval and subsidence, and the great modelling agents at work on different kinds of rocks. The marvels of the Himalayan scenery, the enchantment of Kashmir, the great Grand Cañon of Colorado in North America, the remarkable Cheddar Gorge in England, the Karst scenery east of the Adriatic, all result from the work of great world forces which have been shaping the world for ages. The dry land is indeed subjected to the ceaseless action of various forces; sun and frost, rain and flood, glacier and torrent, wind and wave are continually at work, changing its appearance almost after the manner of a living artist. No part of the original crust is now visible. The hardest rock has been reduced to fine sand or soft clay, and troughs have been filled up with the materials thus made available.

The internal forces that shape the crust—the volcanic eruptions, geysers, earthquakes, etc.—have already been described. Land sculpture is largely the result of the action of three important processes—denudation, transport and deposition or sedimentation; and the modelling agents are the atmosphere, running water and marine forces.

Weathering. The process of destruction wrought by the atmospheric agents is spoken of as weathering, and operates simply through the exposure of rocks to **temperature changes, wind, rain** and **frost**; that is, to the action of weather. **Heat** expands rocks and **cold** contracts them, and such daily atmospheric changes result in the breaking up of the rocks and the formation of soil. This soil is removed by rain, wind or glaciers, and a fresh rock-surface is presented for action by these agents, which thus, by ceaseless operation, bring about slow but steady transformation of the relief of the land. In desert regions, the most important instruments of denudation are the great heating by day and great cooling by night, which lead to alternate expansion and contraction and to the consequent disintegration of even the most resistant rocks; but, in temperate regions, **frost** is perhaps a more effective agent. Rain water enters and percolates through cracks and fissures and frost causes this water to freeze and expand. In this way, alternate melting and freezing also lead to the same result, the disintegration of the rock. The presence of carbon dioxide in this water, however, adds considerably to the effectiveness of this agent. The water becomes a weak acid and slowly but gradually dissolves chalk and limestones, and acts also on other minerals. Thus a granitic rock is eventually reduced by it to sand and clay which are carried to lower levels. Hence a rough surface with crevices and cracks permitting the penetration of water assists the process of disintegration. Weathering is the result of the combined operation of many agents and it is not possible to trace the work of each agent separately. The work of **rain and wind,** however, is often clearly marked. Apart from the chemical action of the rain water, there is mechanical action, whereby the disintegrated rock material left behind by glaciers and other agents of land sculpture are carried away.

Wind acts much in the same way as running water ; the rock fragments are blown away by it and deposited elsewhere. The slope or the relief of the land does not control winds, and wind erosion ultimately tends to fill up hollows and level up the land surface. Wind is a powerful agent of transport ; it can carry small particles to very great distances, whilst fine volcanic ash, meeting stronger air currents in the upper layers of the atmosphere to which it is raised, is carried to even greater distances.

In deserts, wind erosion is perhaps the most active agent of denudation. It slowly but steadily wears away even the most resistant rock, and the large quantities of wind-blown sand intensify the erosive action, and deeply groove and scar rock surfaces on the edges of deserts and great plains. The sand itself may be sea sand, finely pulverized rock waste brought down by rivers or thrown up by waves. In deserts, however, sand is formed as a result of a large range of daily temperature with its consequent alternation of rapid expansion and contraction ; the rock disintegrates into fine sand, which is thickly spread over the surface. In the desert regions of Rajputana, Sind and Baluchistan, mechanical disintegration resulting from extremes of temperature and wind-action is the most dominant agent of land sculpture. The terrific sand-storms in deserts build up the sand into giant waves that appear to be petrified, never advancing, never receding, but remaining there as huge undulating ridges. Yet the waves and troughs do actually change their positions. Wind sweeps the heavier particles along the ground and when these meet with some obstacle, they form a little heap, a **sand dune,** which increases gradually in size. The sides of a dune are usually extended and give it a crescent shape, but the crescent shape is lost when several dunes coalesce.

Winds form sand dunes not only in interior desert regions, but also near coasts where their strength is particularly great. Thus, the western coasts of Denmark, the Netherlands and France are remarkable for such formations. Sand dunes are a common feature along the Malabar coast where they have helped in forming the characteristic lagoons and backwaters. The larger dunes remain stationary, but the smaller ones move, and these movements so seriously encroach upon fertile areas that great devastation has often resulted. Active steps have been necessary to arrest the advance of the destructive dunes in the areas affected. This has been done by planting trees and thereby binding down the sand.

It is interesting to note that wind action is also to some degree responsible for covering extensive areas with a soil of exceptional fertility. This soil is known as **loess** and is found in many parts of the world, for example, the valleys of the Rhine, the Danube and the Mississippi, but most notably in north China, where it is yellow.

Running water. The atmospheric agents produce much greater sculpturing than other agents, since the field of their operation extends to the whole land surface, while the sphere of influence of running water is restricted to the beds over which it flows, and the sea affects coastal lands only. But it must be recognized that running water influences life and development all over the world very profoundly by its complex action as a modelling agent.

Three definite stages, with distinctive well-marked characteristics can be recognized if we follow the course of a river.

(i) **Upper course** or **torrent track.** Here the slope of the bed, and therefore the rate of flow is greatest. The movement of the stones at great speed wears a deep, steep-sided channel, and the force of the current continually dashes the smaller pieces against masses of rock that fall into the torrent from time to time. This ceaseless action gradually breaks up the rock masses into pebbles, which, by further erosion during transport by the river, become smaller and smoother and at last reach the sea as materials ranging down to the finest silt. It is in this stage of the tumbling, jumping torrent that we meet with waterfalls.

(ii) **Middle course** or **valley track.** The slope is gentler, and the force of the current is reduced, but the volume of water is greater, many tributaries having by now added their waters to the main stream. The variegated rock-load brought down by all these is carried forward, together with the material the river has loosened from its own bed and banks; the valley is being further deepened and widened, but at the same time deposition of the heavier fragments thus carried has begun to take place.

(iii) **Lower course** or **plain track.** The river is broad and deep and the current is slow. In the first stage, erosion predominated; in the second, transport was important; but in this third stage, its main work is constructive; sedimentation and deposition are prominent. The river moves across the plain very slowly in curves or meanders. The rock fragments brought down by it are now arrested and deposited, while the finer particles are carried farther towards the sea or the lake which receives the river. The slope of the bed is here very slight; and where the plain has been formed by erosion of once higher land, it is called a **peneplain.**

If the river flows into a lake, a land-locked bay or a tideless sea (such as the Mediterranean Sea, the Bay of Bengal or the Gulf of Mexico), the layers of the earth deposited one above another, year after year, for thousands of years, form a **bank** that rises above the surface. The river splits up into two streams, one on each side of the bank. Each of these streams similarly breaks up into two by a new bank formed at its mouth, and the process continues. At length, in this way, firm land is built up, and as the tract is more or less triangular it is called a **delta.** Great rivers in this manner build up large areas of land at their mouths. The Nile Delta comprises a large part of the fertile portion of Egypt, and lower Bengal is largely the Ganges-Brahmaputra delta. Most of the rivers of India and Burma which fall into the land-locked Bay of Bengal, for example, the Irrawaddy, Mahanadi, Godavari, Krishna and Cauvery, form deltas, but the best known deltas are those of the

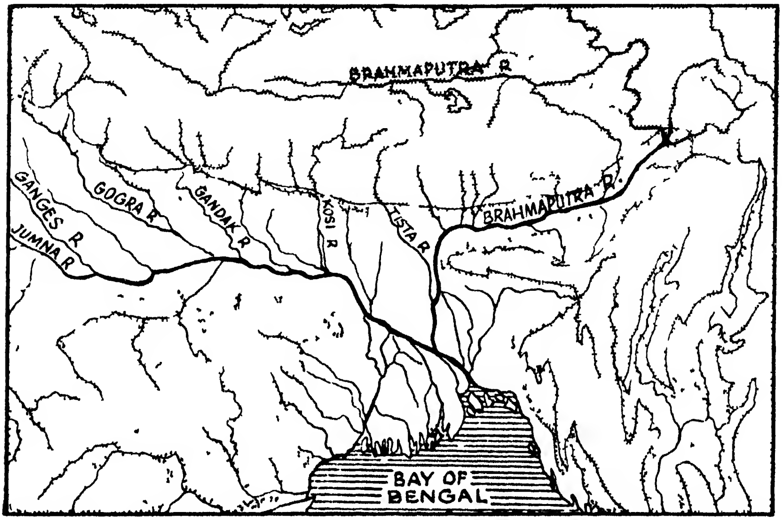

FIG 43 The Ganges valley-plain and delta

Ganges, the Nile and the Mississippi An idea of the enormous amount of land-building material transported and deposited by big rivers at their mouths can be obtained from an estimate which puts the silt brought down to the sea by the Mississippi every year at more than 400 million tons.

Where a river flows into the open sea, its mouth remains clear. The silt is in some cases deposited near the mouth and forms a **bar** as in the case of the Narbada; certain other rivers deposit their load farther out at sea, and this leads to the formation of **sand-banks**. Sometimes the mouth of the river widens as it approaches the sea and a funnel-shaped mouth or an **estuary** is formed, as in the case of the Tapti and the Narbada. Where the river passes between hard rocks, the mouth becomes wider and deeper as the sea is approached, when it is called a **ria**. In some cases, however, the river widens in its approach to the sea, but narrows again and then becomes wider and shallower, the mouth being called a **fiord** (Fig. 44).

Such fiords are common enough in Norway, and in Scotland where they are known as **lochs**.

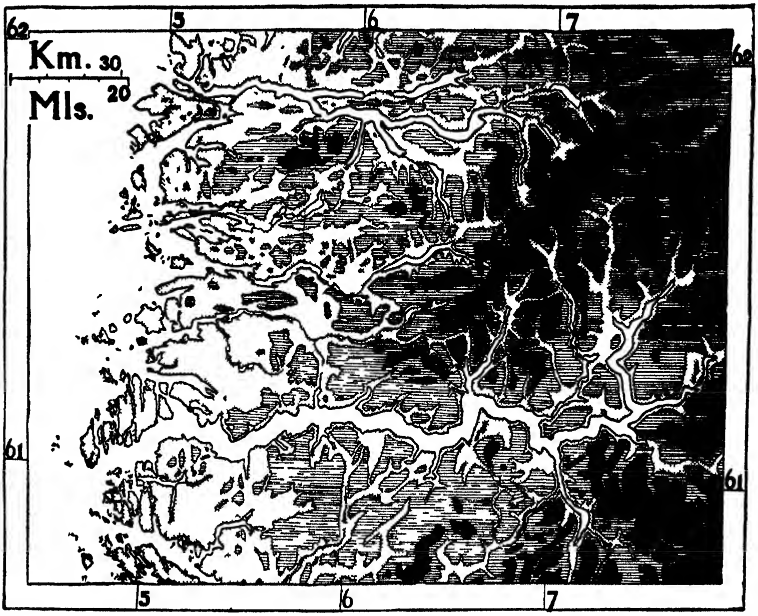

FIG. 44 A typical fiord

When a river has its source in a glacier, it issues as a milky stream. The ice caves from which the Ganges and the Jumna emerge, the **Gangotri** and the **Jumnotri**, are glaciers on the Himalayan slopes. The first river system on any newly-raised surface follows entirely the slope and irregularities of the land. Each little stream of the system, however, begins its work of deepening and widening the valley, each at its own rate. There may be heavier rainfall in one valley, a softer rock in another, a steeper slope and swifter current in a third; and the differential rates of erosion may favour one stream and enable it to capture some of the waters of the others. Such changes result in the replacement of numerous small rivers and streams by a few large river systems. Many of the Himalayan rivers in their upper course illustrate these phenomena of river-capture, the best examples being afforded by the Ganges and the Tista. Some of the original streams are in this way cut off from their head waters and the valleys through which they flowed now become dry valleys. The young stream as it

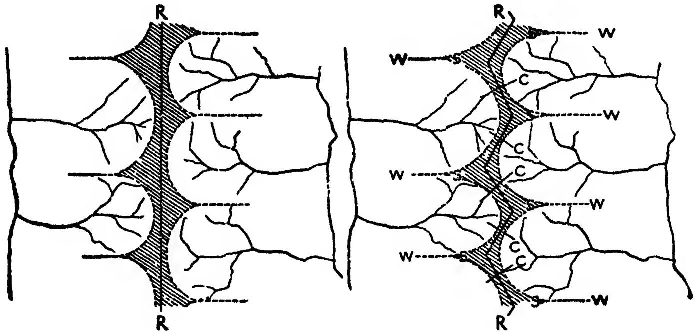

FIG. 45. River-capture

emerges from its source flows swiftly downwards and the irregularities of the surface over which it tumbles and hurries lead to waterfalls, rapids and chains of lakes. The slope of the bed of a river from its source to its mouth is often shown by a section which is called a **profile.** The initial profile of a river

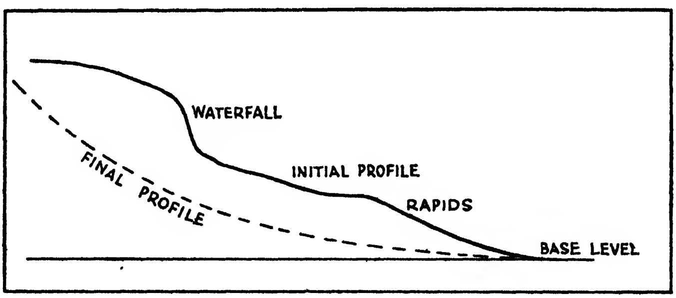

FIG. 46. A river profile

is thus very irregular, but as the work of erosion progresses and the river grows older, the irregularities are reduced, the slope becomes gentle and gradual, the valley becomes wider and the flow becomes more even. It may be noted, however, that it is not only the original inequalities in the land surface that give rise to waterfalls and rapids; these may in some cases be brought into existence rather as a result of differential erosion, by running water, of unequally resistant rocks. Among the best known waterfalls of south India are the Gersoppa Falls of the river Sharavati where the water tumbles down in one single fall from a height of 850 feet, the Sivasamudram Falls of the Cauvery in Mysore, the Gokak Falls, the Yenna Falls of the Mahabaleshwar hills and the Dhurandhar Falls of the Narbada at Jubbulpore.

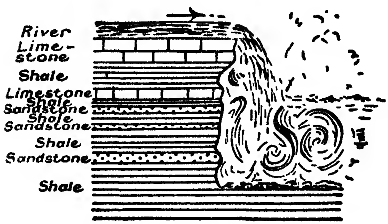

FIG. 47. Niagara Falls

Dissection of plateaux. The work of rivers is not merely confined to smoothening their profiles, and widening and deepening their valleys. Long continued erosion by them produces remarkable changes in the surface configuration of their basins. Crossing a plateau

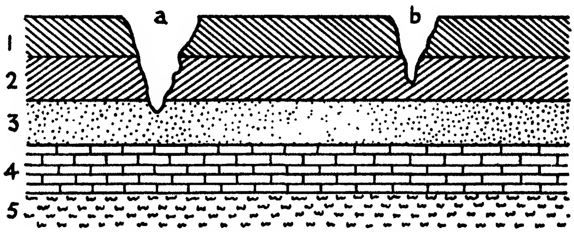

FIG. 48. Dissection of a plateau—I

of stratified rocks (Fig. 48) they cut down into the layers of rocks and carve out deeper and deeper channels (Fig. 49).

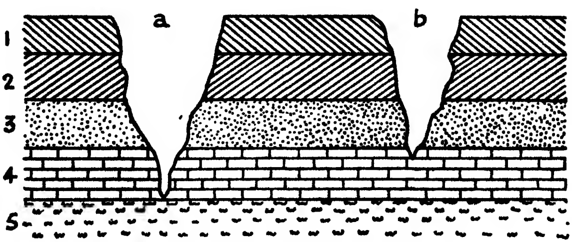

FIG. 49. Dissection of a plateau—II

In course of time, the steep sides are acted upon by atmospheric agents which gradually break up the surface, the fragments falling into the river bed and being carried away. The narrow gorges widen and the plateau assumes a different aspect. The upper bed of rock has practically all been removed and a new layer has now been exposed for action by the rivers (Fig. 50.). The plateau is being dissected, modelled and

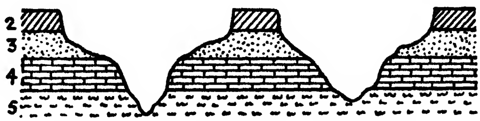

FIG. 50. Dissection of a plateau—III

sculptured into high ridges and deep hollows, so that we now have a series of mountain ranges and valleys as in Fig. 51.

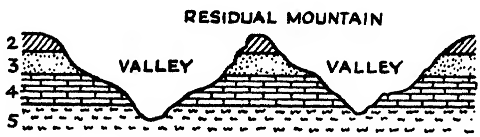

FIG. 51. Dissection of a plateau—IV

In some cases there is but little rainfall, and the deepening of the gorge goes on at a quicker rate than its widening, and great chasms like the Grand Cañon of Colorado are formed.

No river flows quite straight; it slowly winds its way across the plain in a series of curves or meanders. At these curves, the stronger current flows under the banks. The current presses against the concave side of the valley, constantly

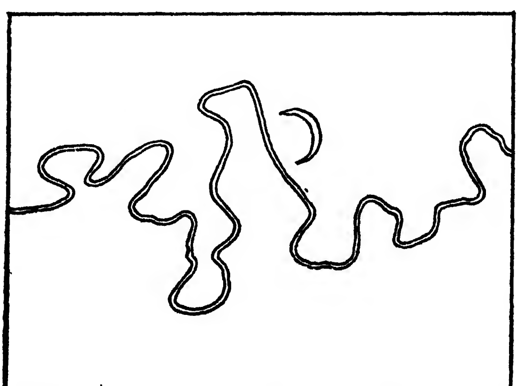

FIG. 52. Meanders

undercutting it, and deposits the gravel and fine waste near the opposite bank. This continuous undercutting leads to the fall of the overhanging rock masses, so that the river valley has one side steep and precipitous and the other worn, weathered and gently sloping. In course of time the river bends become more numerous; the force of the current is applied farther down the river, the overhanging cliffs collapse and give place to gently sloping banks and the river passes on its way in a broad and flat valley, which is known as its **flood-plain.** The flood-plain is indeed the most characteristic feature of the lower part of a river's course, and it is very fertile on account of the deposit thereon of the alluvial waste when the river waters, which cover it during floods, recede.

The different stages in the development of rivers and their valleys, being associated with the lapse of time, are often indicated by referring to them as young, mature or old. A young river is like a river in its mountain track, with a narrow gorge for its valley, an irregular profile, with rapids and waterfalls, quick erosion and rapid transport, and little sedimentation. A mature river shows the features of the valley track with a wide valley and graceful meanders, with the processes of erosion, transport and sedimentation all actively going on; while an old river, with a regular profile and a broad flood-plain, is most active in the matter of sedimentation only. The Ganges affords a very good example of an old river. The great peneplain of northern India is an alluvial valley filled with the soil brought down into it by the Ganges and Jumna, its left bank tributaries from the Himalayas on the north, and the Chambal, the Son and other rivers from the Vindhyas on the south. The peninsular rivers of India are all of still greater antiquity and by ceaseless deepening and widening of their channels, have reached the last stage of river-development, the base-levelling of a continent.

It must be noted, however, that youth, maturity and old age in the case of rivers do not depend upon time alone. Specially resistant rocks and dry climates preserve the characteristics of youth for a long time. On the other hand the increase in the volume of water in a river as it flows towards the sea, and consequently the increase in its working power, produce significant results. Many rivers thus show all the three stages, youth in their upper courses, maturity in their middle courses, and old age in their lower courses. Old rivers remove all inequalities and irregularities on the surface in course of time and form a very flat and extensive region, called a peneplain. But crustal movements may create fresh inequalities of relief and restore activity to old rivers. The peneplain becomes a plateau and is subjected to fresh dissection by the old rivers, turned young again.

A continental land mass is, in course of time, through the action of the various agents of sculpturing the surface, divided into distinct river basins, separated from one another. The rain water received by each, and not lost by evaporation or absorption, ultimately flows out through the tributaries and the main stream into the sea. The whole of each such area, draining thus through one river system, is called its **catchment area.** River systems, indeed, play a very significant part in shaping, moulding and directing the progress and development of their catchment areas. The fertility of a basin depends largely on the volume of water and the force of the current of the river, which regulate the strength of its power of erosion, transport and sedimentation ; the origin and growth of villages and towns depend largely on the navigability and direction of the river ; and the economic activities of the people of the region are largely regulated by the general features of the basin. A river basin is thus a definite geographical unit, marked by a great degree of homogeneity of social, economic and political conditions, and the study of modern human geography is in a great measure the study of river basins.

Lakes. Lakes are formed in depressions or hollows hedged in by elevated surfaces, such hollows being due to the action of the external or internal modelling agents.

The gradual accumulation of sediment may obstruct the outflow of a river ; it becomes a natural dam, the water above is held back and a natural reservoir or lake is formed. Screes and landslips similarly block up valley exits and create lakes. The small lakes of Bundelkhand and the Gohana Lake of Garhwal, formed by a huge landslip across a tributary of the Ganges in 1893, are examples of this type. The erosive action of overflowing water soon weakens the dam, which suddenly bursts and releases a large volume of water into the valley below. Such phenomena are often met with in the upper waters of the Indus. Marine deposits form lagoons or salt water lakes like the Chilka Lake of Orissa and the Pulicat Lake of Nelpore ; but glacial action is one chief cause of the formation of lakes. Organic deposits, animal or vegetable, act in the same way as in the case of the lagoon of an atoll. Lakes are also commonly formed in the natural hollows provided by the craters of volcanoes, as in the case of the famous Lonar Lake in Berar. Sometimes lakes are formed in rock-girdled hollows, and the Anasagar at Ajmer is a good example on a small scale. Such lakes may, however, be found also in the course of a river, Lake Wular, through which runs the Jhelum, being a good example. Other lakes owe their origin to hollows resulting from crustal movements with their fracturing, faulting and subsidences, and the great faulted basin in south-western Asia and eastern Africa gives us good examples like the Dead Sea, Lake Tanganyika and Lake Nyasa. The Great Lakes of North America and the larger Alpine lakes also probably have a similar origin.

As a general rule a lake receives more water than it loses by evaporation, so that a river issues from it. But it will have no such outlet in regions of low rainfall, high temperature and great evaporation. This leads to a concentration of salts brought down in solution by various streams to the lake which thus becomes more and more saline. There are, moreover, lakes through which rivers pass. All incoming streams bring to them silt and rock waste. This may gradually build up deltas, and in course of time the lakes became practically filled up, and form lake-plains. Such lakes act, however, as filters in so far as the deposition of the rock waste leaves clear water for the outgoing streams. Lakes further regulate the flow of rivers, for the sudden addition of a large volume of water, which might cause floods if carried directly forward, does not materially cause disaster when spread over their large surface.

Underground water. We have seen how important is the work of running water in sculpturing the crust of the Earth. Valleys, plains and plateaux are all created and shaped by it in various ways. The work of underground water in modelling the crust of the earth is also of considerable significance. Some rocks are porous or pervious, and rain water sinks through these till non-porous rocks are met. The water collects in them up to a certain level known as the **level of saturation,** or the water-table, and emerges at the point where the surface is below that level. A **spring** is thus formed. The level of saturation varies with the season ; the dry season gives the lowest limit, which is the permanent level of saturation ; and wells sunk to this permanent level will always have water in them. Similarly, springs will be permanent or intermittent according as they lie below or above the permanent level of saturation. Sometimes a porous bed lies between two impervious beds and is bent as in Fig. 53. The rain water will

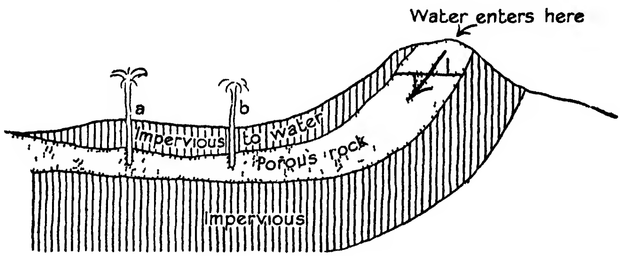

FIG 53 Artesian well

sink into the pervious bed (for example chalk) and as it cannot go farther below, it will saturate the chalk up to the rim of the basin. If this level of saturation is much higher than the chalk bed where it is curved, and a boring is made into the chalk through the upper impervious layer, for example, clay, the water will rise above the ground sometimes as a fountain. Deep wells of this kind are known as **artesian wells** and have been of great use for irrigation in Australia and many other parts of the world. They do not occur commonly in India. The best known examples are those of Quetta with the **Karez** in the great gravel slopes of Baluchistan. Artesian wells are sometimes possible in the alluvial districts of north India and in Gujarat, where there are successful borings at Navsari, Viramgam and Mahi.

In regions which are still being or have been subjected to volcanic activity, the springs have often warm and even hot water. The high temperature of the water is probably due to its origin at great depths and to chemical changes that go on in the interior in such regions. Such **thermal springs** are found in many parts of the earth and New Zealand has quite a large number of them. The hot springs at Bath and Carlsbad are quite well known. In India, too, we have many thermal springs in different parts of the country, especially in mountainous districts like Sind, Assam, the Salt Range and in the foothills of the Himalayas. The Sitakund, near Monghyr, is well known and so is the spring at Gangotri. About fifty miles from Bombay, there are the hot springs of **Vajrabai** or **Vajreshwari,**

[*By courtesy of Mr M D Shroff*

FIG. 54 Hot springs at Vajrabai, near Bombay

the waters of which closely approximate to those of Bath. They are supposed to be radio-active and contain a good deal of iron and calcium, and are considered to alleviate rheumatism and similar complaints. The springs form one group in a line which appears here and there along about four miles of the course of the Tansa river.

In most springs of this type the water is just pleasantly warm, but in some of them the temperature is too high for bathing. It is to groups of springs such as these that many famous spas like Harrogate and Vichy owe their prosperity. And yet, though Vajrabai has all the potentialities of an attractive holiday centre, it retains its pristine simplicity and obscurity.

Springs play an important part in the development of regions, for they not only supply fresh water and increase the volume of water of rivers, but by their thermal or mineral properties materially influence the distribution of population.

Rain water containing much carbon dioxide easily dissolves certain kinds of rocks, and limestone regions particularly show very remarkable effects of this action of running water. Water finds its way through crevices in the rock, and in its passage deep into the earth dissolves the limestone, widens and deepens its underground channels and ultimately carves out large caverns in the rock. The water, slowly trickling through, partially evaporates and deposits a thin film of lime at the top of the cavern, and another on the floor where the water drops from the roof. In this way evaporation and deposition go on for centuries, so that in course of time, the lime deposits hanging down from the ceiling (called **stalactites**) lengthen, and the floor deposits (**stalagmites**) grow in height, till they unite and form a limestone pillar. The only instances of such cave deposits in India are to be found in a few caverns in the Karmul district in the south. Limestone districts have peculiar characteristics. The soil is thin and the regions are often very bare. The typical scenery of such districts is met with in the Karst district of Austria, in the Pennines in England and the Vindhyas in India. As chalk is softer and more porous than limestone, we do not find the same well-marked characteristics in chalk districts, though they are often similarly bare with only a thin layer of soil upon them.

Snow and ice. Snow is not generally, in itself, a disintegrating agent; it rather protects the underlying rocks. But when great masses become detached, during winter storms, they fall as avalanches with great destructive effects, burying everything under them. Large fields of snow covering hollows in mountains have ice underneath. This mass of ice, the glacier, moves slowly down the steep valleys, scoring and tearing the hardest rocks and carrying the rock waste along till it reaches a level a little below the snow-line, when it melts and forms a river. The action of glaciers is strongest at the bottom and sides, and the glacial debris is left in long ridges at the sides (**lateral moraines**), or is carried along on the ice (**medial moraine**) when two or more such rivers of ice have joined, or is deposited where it melts (**terminal moraine**) and gives rise to a river. Many of the Himalayan glaciers are some three miles in length ; but there are some giant glaciers of twenty-four miles and more, as, for example, the Hispar and the Chogo Lungma of the Hanza valley in the Karakorams. These have extensive superficial moraine-matter which almost completely covers the upper surface, so that for long stretches ice is not visible.

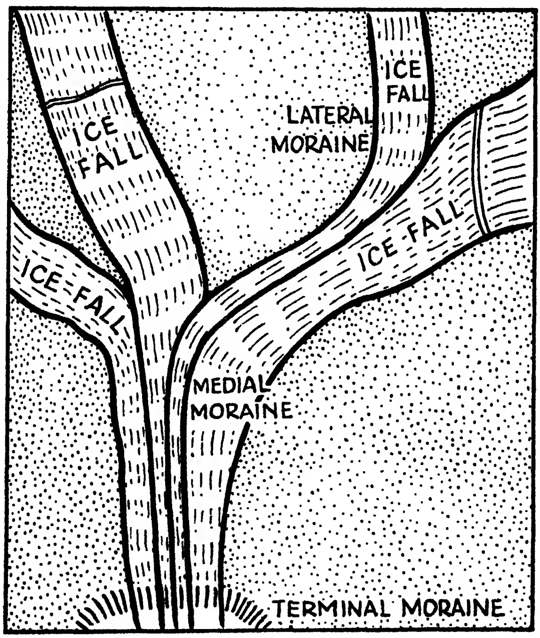

FIG. 55. A glacier, showing moraines

Where a mountain range is close to the sea coast, a glacier, as it descends the valley, may enter the sea. The ice floats upon the water and an **iceberg** is formed, about eight-ninths of the volume of which is below the surface and only one-ninth above. The fragmental material carried by the glacier is now borne away by the iceberg, and deposited upon the bed of the sea as the iceberg melts. It is probably in this way that the Banks of Newfoundland and the Dogger Bank in the North Sea have been formed.

Glacial action is often very striking. The rocks are smoothed and rounded, the floor is scratched and channelled; moraines are formed; boulders and erratic blocks are carried long distances; boulder-clay is deposited over large areas; U-shaped valleys and rock-hollows are scooped out. And yet in many parts of the world, we find these effects of the slow but resistless action of moving ice though there are now no glaciers nearby. This is probably due to the fact that in the course of geological history, great climatic changes have occurred in various parts of the earth. The whole of northern Europe, for example, is commonly held to have been at one time covered with an almost continuous ice-sheet, which spread the boulder-clay over the plains.

The work of the sea. The sea is an active modelling agent and is important as regards both denudation and deposition. The waves constantly cut back the coast-line, erode it in huge cliffs, or cover up the low lands. The alternation of hard and soft rock in coastal lands results in differential erosion. Graceful curves are formed on the coast, and the more resistant rocks stand out as headlands. The denuding effect of the sea on rock, assisted by the atmospheric agents, produces cliffs, sea-caves, blow-holes, stacks and needles, caves and bays, fretted outlines, spits of sand or shingle and creates a scenery, the features of which vary according to the nature of the rock and the climate.

The sea, like the rivers, is a constructive agent also; it not only destroys lands but builds them up. The waves erode the coast-line at one point, and the rock waste is caught up by currents on the shore and deposited elsewhere. Ultimately all the solid material thus loosened and removed is deposited on the floor of the sea where it helps to fill up hollows.

Changes on the coast-line are often brought about by the slow depression of a large area, and the intrusion of the sea near the edge of the land and into the river valleys. With soft rocks to work upon and a low-lying land, the valleys will be broad and shallow and often very winding; but they will be narrow and deep where the land is high, rising steeply from the sea where the rocks are hard. Norway and western Scotland show this type of steep and rocky coast. Where, however, a new coast-line is formed by the subsidence of a mountain range, the sea will enter the longitudinal valleys; the outer chains of the range will then form a series of islands off the mainland, and the valleys will be filled with water and become long and narrow gulfs parallel to the coast-line. The Dalmatian coast and the Tenasserim coast of lower Burma are good examples of this type of coast-line.

Elevation of the land mass is responsible in some cases for changes in the coast-line; a part of the continental shelf rises above the surface of the water and appears as a low-lying, narrow and often marshy coastal plain. Such a coastal plain has a very gentle slope seawards; the coast-line is very regular except where it is broken by the estuaries of rivers; and the narrow plain ends where it meets the cliffs which originally bordered the land mass. The Atlantic coast of the United States is largely of this type. The plain is bounded in the north by a steep wall down which rivers tumble, forming rapids and waterfalls, which are useful as a source of hydro-electric power. The edge of the plateau is known as the **fall-line,** on which are to be found many of the important towns of that country. A similar type is met with on the western coast of India, where the Western Ghats become a sort of a fall-line, important as a source of power. Mythology explains this elevation of the land, the recession of the sea and the formation of the plain as an exploit of the legendary hero, Parasuram. An entirely different type of coast is produced where mountain-building movements have been pronounced. The elevation of a submerged mountain range will lead to the formation of archipelagos outside the mainland coast. The West Indies, the Malay Archipelago, and the island-festoons off the coast of eastern Asia have been formed in this way, the land-locked seas of eastern Asia being probably due to the sinking of large areas during the upheaval of mountains. Sometimes, when there is a fault near the coast-line, there is subsidence of the coastal blocks; the new coast-line is then more or less identical with the line of fault and will therefore be steep and nearly straight. The Chinese coast has been formed in this way.

The coastal lands, it must be noted, are geographically the most important part of land masses. The history of exploration and settlement shows that penetration and occupation of large areas have always been from the coast inland. Commercial centres develop on the coast, while the dense jungles and forest swamps in the interior are left alone for savage beasts and primitive men. Even today many of the most important cities of the world are on coastal margins, for example, London and New York, Bombay and Calcutta. Coastal erosion, where extensive, is therefore a serious matter, and must be checked as far as possible. It is consoling to reflect, however, that great as is the loss by coastal erosion, the constructive action of rivers and reclamations undertaken by men more than compensate for it.

4. ROCKS

Ordinarily the term **rock** is applied to a hard and resistant substance, but in geology all the solid materials forming the crust of the Earth are called rock, whether hard or soft. A rock is not a uniform compound made up of several chemical elements in a definite proportion, but is a mixture of various materials. Thus a limestone consists chiefly of carbonate of lime, but clay also may be present in it ; while a clay, though largely silicate of alumina, may also have considerable quantities of carbonate of lime.

Rocks fall into two principal types according to their origin—**igneous** and **sedimentary.** Rocks of either of these two classes, however, are in some cases so greatly affected by heat, or pressure, or both, that their distinctive chemical and physical characteristics are completely altered, when they are known as **metamorphic rocks.**

Igneous rocks. These rocks have been formed of the hot molten material underlying the crust in the interior of the Earth. This molten material forces its way outward to the surface, as in volcanic eruptions, and solidifies ; or it may press its way up fissures or between layers of sediment where it cools and solidifies deep down beneath the surface. The cooling process in the interior is slow, permitting crystallization of the minerals constituting the rocks, so that such **plutonic rocks,** like **granite,** are always completely crystalline. The molten material which sometimes forces its way to the surface solidifies on the way and forms intrusive dykes, or more or less horizontal sheets, which are less crystalline inasmuch as the cooling is in this case more rapid. Where the molten rock comes out to the surface as lava, the cooling is yet more rapid, and the process of solidification quick, so that many lavas do not crystallize at all. **Obsidian** is a good example of such **volcanic rocks.** Thus igneous rocks usually occur in large shapeless masses and not in layers, and are therefore most frequently of the **unstratified type.**

Sedimentary rocks. Denudation, as we have seen, is always associated with deposition, leading to the building up of new land elsewhere. The rock fragments and debris removed by the agents of denudation are merely transported from one place to another and deposited in deep hollows or low-lying plains, or on the sea-bed or the bottom of great lakes. Great layers of strata of denuded material thus accumulate and get piled up to thousands of feet, and, under great pressure, become welded together and harden, forming in time new and solid crust. During great mountain-building movements, with their upheavals and subsidences, the sedimentary layers accumulating in this way under the sea for ages reach the surface as rocks, thousands of feet in thickness, spread over large areas. These are known as **stratified rocks** from their arrangements in strata, or layers. But they are also called **sedimentary rocks,** from their origin, and **aqueous rocks** from the fact that they have been originally deposited on sea-beds or lake-bottoms. The Vindhyas are for the most part composed of horizontally-bedded sedimentary rocks of ancient age.

Sedimentary rocks fall commonly into four classes according to their composition : sandy, clayey, chalky and carbonaceous. Sandstone and grit are sandy rocks composed of grains of quartz; while clayey rocks, like clay and shale, which is hardened clay, are largely made up of clay (which is silicate of alumina), though deposits of very fine particles of other minerals may also be there. Many limestones are formed of carbonate of lime and consist mainly of hard shells and skeletons of marine organisms or plants, while coal and lignite, formed from the remains of plants solidified under great heat and pressure, form the fourth class of sedimentary rocks.

Metamorphic rocks. Older rocks which have been long covered over by huge quantities of later deposits are in time completely altered in appearance and structure, chemically and physically, and may be exposed to view at the surface by crustal movements and denudation. Such old and altered rocks are called metamorphic. These are usually crystalline like plutonic rocks, but are frequently arranged in layers and are often found as the central axis of a great mountain chain. Marbles are thus derived from limestones, and slates from clays and shales, while gneisses and crystalline schists, so common in south India, are derived from other rocks.

5. THE OCEANS AND OCEAN MOVEMENTS

Knowledge concerning the mysteries of the ocean, beyond what could be observed from the shore or from ships sailing on the ocean surface, has been possible only during the last hundred years or so. Special scientific expeditions have been sent out, and these have gathered a great deal of useful knowledge of the oceans, their movements and the great variety of life in them. The earliest important expedition of this nature was the one undertaken in the Atlantic in 1872 by the **Challenger,** sent out by the British Government with the object of oceanic surveying preparatory to an extension of telegraphic communication across the ocean to America. The **Tuscarora** was similarly fitted out for exploration in the Pacific in 1874. Most of the great countries of the world, following the example of Great Britain, have sent out expeditions, and these and numerous private expeditions have contributed to the collection of a considerable amount of knowledge. Much excellent work was done by the German ship **Valdivia** in 1898. The great Arctic explorer, Nansen, supplied very useful knowledge of the Arctic, and various Antarctic expeditions have similarly increased our stock of knowledge of the Southern Ocean and Antarctica, while recently a similar expedition has been working in the Indian Ocean. A vast amount of knowledge of the different oceans has thus been obtained through the scientific expeditions fitted out by the leading civilized nations of the world to undertake the work of studying the depths, temperatures, salinity, currents and the different types of creatures found at different depths, as well as the nature of the deposits of the ocean bed.

The ocean floor. We can divide the ocean floor into four parts. There is the **continental shelf,** which is a sort of continuation of the continental shore-line, sloping very gently from the shore to a depth of about 600 feet or 100 fathoms. The **continental slope** is just outside this submarine platform and slopes very steeply down to about 2,000 fathoms. Next, we have the **deep-sea plain**, representing the general level of the ocean floor. It is a vast and more or less level area with but gentle slopes, the depths exceeding 3,000 fathoms. Lastly, there are the **deeps,** which are depressions in the deep-sea plain. These have very steep sides, but are not extensive in area, and are to be found generally nearer the margins than the middle of the oceans, particularly near the coasts where mountain-building movements, with volcanic eruptions and earthquake shocks, are actively operating. The continental shelf and slope may have their origin in earth-movements bringing about an elevation of the sea floor or a subsidence of the land ; or in the erosive action of the sea or in the deposition of material, derived from the land, accumulating as a submarine platform upon continental margins; or they may result from the combined influences of erosion and deposition. The deep-sea plain is not covered over with river sediments, but by a kind of fine mud, **ooze,** consisting of the shells and skeletons of sea creatures and plants. Mingled with such deposits we often find the debris thrown out by submarine volcanoes, while the red clay, formed chiefly from the fine ash ejected during volcanic eruptions and carried over the oceans by the wind, is also often found in the sea plain, but is more generally noticeable in the deeper parts, as the proportion of other deposits is there smaller.

Salinity. Compared with the fresh water of rivers, sea water contains a larger percentage of salts in solution, the proportion of the various salts again being different. In sea water, **chlorides** predominate, particularly sodium chloride or common salt ; in river water the **carbonates,** particularly of lime, are important. The difference between sea and river water is explained by the constant evaporation of water from the seas whereby the sea water is left with more or less the composition of concentrated river water, while the use that various marine organisms make of the carbonates to build up their shells or skeletons perhaps explains the predominance of chlorides in sea water. Sea water is heavier than fresh water because of the matter it thus holds in solution; its normal specific gravity is 1·028.

Sea waters are not all equally saline. The mean salinity is 35 parts per thousand or 35 ‰. Deviations from this mean are due either to concentration by evaporation or dilution by rain and river waters. Thus salinity is very high in regions of rapid evaporation and scanty rainfall as in the Red Sea and the trade wind belt; and is low in the equatorial regions because of the heavy rains, and in higher latitudes where rainfall is greater and evaporation less rapid than in the trade wind belts. The larger volume of water poured in by great rivers like the Congo and the Niger is responsible for further lowering the salinity in the Gulf of Guinea, while nearer the polar regions, the salinity is lowered at certain seasons by the melting of ice. In land-locked seas, like the Mediterranean and the Baltic, salinity depends upon the balance between the loss of water by evaporation and the gain by rainfall and rivers. The inflow from the German, Russian and Swedish rivers lowers the salinity of the Baltic Sea to less than 12 ‰, while the Danube, Don, Dniester, Dnieper and other rivers give comparatively fresh waters to the Black Sea. The balance is, however, unfavourable in the Mediterranean and Red seas where evaporation is rapid, the rainfall is low and rivers supply but a small amount of water compared with the area of the seas. In the case of inland seas and lakes without an outlet, evaporation more than balances fresh supply, and there is greater and greater concentration of the salts brought in by the rivers entering them, and the water becomes increasingly saline. The Dead Sea waters are thus very salt, the salinity reaching 250 ‰ and the salinity of the Great Salt Lake in the United States is 220 ‰; the Sambhar Lake in Rajputana is also very saline, the salt being wind-borne, derived from the evaporation of the sea-spray from the coasts, and partly from the dissected surface of the Rann of Cutch. It must be noted that the salinity of the surface water is in general much higher than that of the deep-seated water. At great depths the water, being colder, is even denser than salt water, and remains therefore fresher than the surface water.

Ocean temperatures. The temperature of sea water varies with the depth of the water and its latitude. The surface temperature generally varies from about 80° F. near the equatorial regions to about 28° F. in the polar regions. A further fall of temperature would lead to freezing of the surface waters, but beneath the ice the temperature of the deep-seated water rarely goes below 28° F. Winds, ocean currents and the distribution of land and sea are the chief factors that govern the wide variations of local temperatures. In the case of waters below the surface, the temperature decreases with depth, though the rate of fall is not uniform, being high to start with, low at intermediate depths, high again and very low at great depths where the temperature is about 35° F. or just a little above freezing-point. In enclosed seas, like the Mediterranean and the Red seas, the surface temperature is higher than in open oceans.

The oceans. The great land masses and their continental shelves divide the water envelope of the Earth into clearly marked out parts which we call the oceans, each of which is typical and lies in a distinctive basin. The oceans communicate with one another freely and often have bordering seas. The Pacific, Atlantic, and Indian oceans open widely southwards, but are more or less land-locked on the north. The Arctic Ocean is rather an extension of the north Atlantic, while the Southern Ocean has no clearly defined basin, being rather a depression where the waters of the Pacific, Atlantic and Indian oceans mingle.

The **Atlantic Ocean** opens broadly towards the south and narrows towards the equator between Africa and South America. In the northern hemisphere it is again wide, but narrows polewards. It is peculiar in that it has a large number of border-seas. Thus there are Baffin Bay and Hudson Bay on the west, the North Sea and the Baltic on the east ; nearer the equator, the Gulf of Mexico and the Caribbean Sea on the west, the Mediterranean on the east. Other peculiarities of the Atlantic Ocean are a strongly developed continental shelf, a submerged mountain range in the middle, known as the Dolphin Ridge in the north Atlantic and the Challenger

Ridge in the south Atlantic, and the general absence of deeps, the most important of these being the Blake Deep, north of Porto Rico and Romanche Deep, close to the equator on the west. The average depth of the ocean is about two miles.

The **Pacific Ocean** is a vast expanse of water, about two and a half miles deep, almost completely closed on the north, except where the Bering Strait connects it with the Arctic Ocean, and broadly open on the south. The continental shelf is narrow ; there is no great central divide ; there are numerous troughs and depressions like the Tuscarora and the Atacama deeps along the margins ; there are numerous islands rising from narrow submarine ridges, and isolated plateaux that stand out from the ocean floor.

The **Indian Ocean** nowhere approaches the polar zone. In the north it is connected with the great mid-world depression of which the Mediterranean is the most striking feature, and the ocean floor with its ridges shows considerable similarities with that inland sea. A submarine platform connects India by a kind of bridge with Madagascar and the African mainland, so that the Indian Ocean, like the Atlantic Ocean, has a central divide (Fig. 56). It is a noteworthy characteristic of the Indian Ocean that its world position, coupled with the distribution of the surrounding land masses, has a peculiar effect on the areal temperatures and atmospheric pressures. These factors, combined, are largely responsible for the phenomenon of the great seasonal winds known as the monsoons, upon which the life and prosperity of so many millions of people depend.

Ocean movements. The waters of the ocean are constantly in motion. Under the influence of the wind, waves are set up, the tides pile up waters or lower their level, and a variety of causes gives rise to currents—permanent, seasonal or tidal.

Waves are a movement of the surface only, which is thrown into undulations as when a rope is shaken at one end ; the waters do not move forward at all. In deep water, the surface particles move to and fro, up and down, in more or less a circular fashion. Waves which pass over large sheets of water often grow to a considerable size, and the height sometimes exceeds fifty feet. When a wave approaches the coast, the lower part is retarded by friction with the shallowing

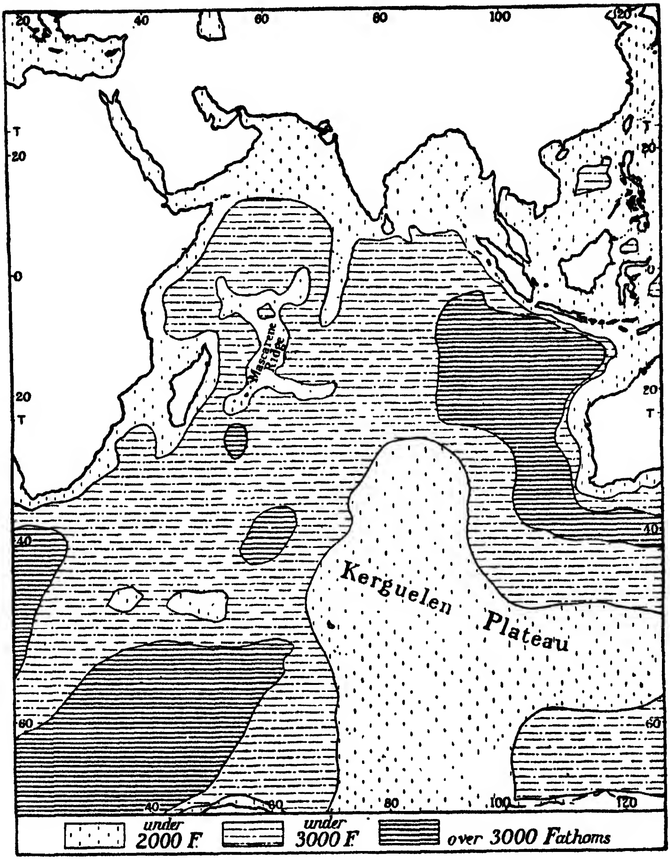

FIG. 56. The Indian Ocean

shelf, while the upper part advances more quickly, falls forward and forms a breaker. It is in this way that on sand-banks the sea, in stormy weather, becomes a vast foaming boiler of breakers.

Tides. From the earliest times, the Indians, Greeks and Romans have known the phenomenon of the tides and grasped its meaning and its connexion with the Moon. Though no satisfactory explanation of the phenomenon was advanced until quite recently, the height of the tides and the intervals between them have been fairly accurately calculated for centuries. Recently the Government of India has prepared extensive tables of tides for the Indian Ocean, and the United States furnish similar knowledge for the Atlantic.

Observations on the seashore show us that tides rise and fall twice in a little over 24 hours. High tide at a given spot is about 51 minutes later each day, corresponding to the Moon's rising so much later every night. The tide attains a greater and greater height towards Full Moon (Poornima) and New Moon (Amawasya) and declines in height towards the quadratures. The range of the highest or **spring tides** may be as much as 27 feet on the coast, but that of the **neap tides,** which neither rise so high nor fall so low, is very much less.

The Sun and the Moon are the two bodies that are responsible for this phenomenon; the Sun because it is so large, the Moon because it is so near, the gravitational attraction depending upon size and distance. The Sun's attraction is certainly much greater; but as tides are due, not to attraction, but to the differences between the pull on the waters on the near and far side of the Earth and on the solid Earth itself, the Moon's influence predominates. The pull of the Moon on the near side of the Earth is greater than on the centre, and the waters of the liquid ocean yield to this difference and are heaped up beneath the Moon. On the other side, the waters being less attracted than the solid Earth at the centre, appear to bulge outwards on the side away from the Moon. It is perhaps difficult to accept this explanation of the spring tides on the Full Moon and New Moon days, but an elaborate mathematical explanation is out of place here. At the first and last quarter of the Moon, the Sun and the Moon and their respective pulls are at right angles to each other, but the result is the heaping up of waters towards the Moon and a bulge on the side away from it, though the tides do not rise so high nor fall so low as at New and Full Moon.

High tide might ordinarily be expected to occur when the Moon is on the meridian, so that all places on the same longitude would have high tide at the same time. But the Earth rotates from west to east and therefore the Moon apparently goes round from east to west, and the tidal wave would be expected to go round the Earth from east to west; but really it travels from west to east or even north to south in certain cases. The reasons are to be sought in the difference between the tidal wave's own proper rate and the rate due to the influence of the Sun and the Moon; but we have to take into account also in the obstruction offered by continental masses and the unevenness of the ocean floor. Only in the Southern Ocean is there no interference by the land masses, and the tides are there free to travel round from east to west. As this wave passes the openings of the Indian, Pacific and Atlantic oceans, branch waves are set up which travel from south to north. But the rate of progress in mid-ocean is more rapid, and the branch waves become so curved that they reach the continental coasts from the middle to the sides. Thus eastern Africa receives the wave from the east and Western Australia from the west.

When a tidal wave enters a shallowing sea or a narrowing estuary, retardation of the front decreases the length of wave, but increases its height, and at Cardiff in the Bristol Channel, the spring tide rises 42 feet, and in the Bay of Fundy, 70 feet. The confinement of the wave within a narrowing space, and the consequent great and sudden retardation which is experienced in a river mouth leads to the broken crest forming a wall of rushing waters advancing rapidly up the river, which is known as a **bore** or **eger.** The great bores of the Ganges and the Yangtze-Kiang are excellent examples, the bores sometimes attaining a height of about 12 feet.

The land masses lead to a splitting up of the tidal waves, and this sometimes has remarkable results. Where the tide can enter from both ends of a sea or a strait, as in the case of the little strait between Southampton and the Isle of Wight, there may be four high tides in a day, or there may be no tide at all as at the mouth of the Rhine, or there may be high and strong tides as in the case of the Thames estuary, according as the two branch waves remain distinct, or neutralize, or reinforce each other. The bifurcation of the tidal wave, by the interference of land, often leads to the formation of sand-banks which make the task of navigation very difficult. The Mediterranean is practically a tideless sea, the narrow entrance to it from the Atlantic counteracting the effects of the oceanic tidal wave. When tidal currents enter narrowing estuaries, they become powerful agents of erosion and transport, so that accumulation of sand is prevented and the channels are kept open for navigation. Such ports as London and Hamburg are benefited by the open character of the river mouths on which they stand.

Ocean currents. These are movements of surface waters, warm or cold, in the different oceans, and are mainly caused by the winds. The steady blowing of the wind and the consequent friction between the moving air and the still water set the latter in motion in the direction of the prevailing wind. This direction is altered, however, by the shape of the land masses and by deflection owing to the rotation of the Earth. The temperatures of ocean waters in the polar regions differ from those of waters near the equator, and these differences produce a surface flow of warm water polewards from the equator, and a flow of cold water under the surface from the poles, equatorwards; but the rate of this movement is very slow and these temperature differences cannot be accepted as the main cause that sets up the ocean currents.

The NE. and SE. trade winds are strong, steady winds blowing in a general westerly direction to meet in the equatorial regions, and drive with them a volume of surface waters. These currents are called the **equatorial currents,** and flow parallel to the equator westwards both in the northern and southern hemispheres until they encounter projecting land masses. They then split up, the main masses passing polewards into higher latitudes, the other branches forming the compensating drift—the **counter-equatorial current.** The main currents now enter the region of the westerlies, are deflected by the Earth's rotation, and, gradually bending away from the land, move eastwards. On striking land on the western margins of the continents, the main branch bends equatorwards and mixes with the equatorial current, while the minor branch goes farther polewards. The movement of the main currents is therefore clockwise in the northern hemisphere, and anti-clockwise in the southern.

Some currents are warm, some cold, the temperature of the waters depending upon the region from which they are flowing. The equatorial current is therefore warm, its main branch is fairly warm on the eastern margins and farther on its passage across the ocean eastwards, and finally the main branch returning to the trade wind belt is cool. Generally, those moving from lower to higher latitudes are warm, and those moving from higher to lower latitudes are cold or cool. When the water that is pushed forward by a current has considerable depth and flows like a river between its banks, the current is said to be a **stream** current whereas, when the surface water moves forward slowly and is broad and shallow, it is called a **drift** current.

The polar winds are also responsible for starting currents, these flowing equatorwards and westwards. On reaching lower latitudes, they meet the mass of warm water flowing polewards and sink below it, ultimately reaching the sea floor. These colder currents are less important; but where they keep close to the coast they exercise a very great influence on the climate of the coastal tracts along which they flow. The absence of large land masses in the southern hemisphere in the region of the westerlies and farther polewards leads to the current steadily moving eastwards under the influence of the brave west winds. In the northern hemisphere, however, the ocean being almost closed, the water moves almost in a circuit. The general arrangement of the currents is something like that in Fig. 57.

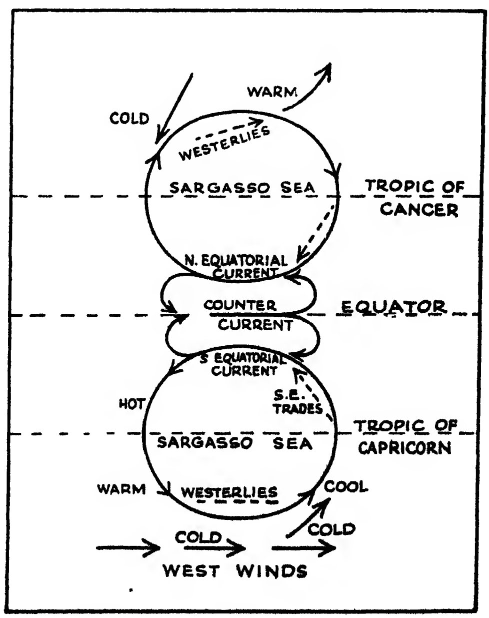

FIG. 57. Ocean currents

Atlantic Ocean. The south equatorial current divides at the north-east corner of Brazil into two branches, one passing southwards along the Brazilian shore and hence known as the **Brazil current,** and the other passing north-westwards along the Guiana coast. This latter branch, together with the **north equatorial current,** passes through the cluster of islands into the Caribbean Sea and the Gulf of Mexico, and emerges through the Florida Channel as the famous **Gulf Stream.** The Gulf Stream becomes a drift current after about 45° W. longitude, and spreads out on the surface and divides into two branches. One branch, flowing towards Spain as the **Canaries current,** joins the north equatorial current after skirting the African coast and completing the closed circuit, while the other, pushed on north-eastwards by the prevailing westerly winds, reaches the British Isles and Norway and mingles its waters with those of the Arctic Ocean. The central area round which the equatorial current and the Gulf Stream thus circulate is a still-water area known as the **Sargasso Sea,** where seaweed has accumulated to such an extent that the passage of ships is considerably obstructed.

Pacific Ocean. The currents in this ocean are very similar to those in the Atlantic. There are the north and south equatorial currents and the equatorial counter-current ; there is the **Kuro Shiwo** or the Black Stream, corresponding to the Gulf Stream ; and there is a Sargasso Sea. The differences in the arrangement of the land masses, however, cause certain peculiarities. The south equatorial current does not cross the equator, and no surface water is added by it to the north equatorial current as in the case of the Atlantic. The warm drift waters driven into the Arctic Ocean between Iceland and Norway find no counterpart here, as the northern outlet of the Pacific through the Bering Strait is very narrow.

Indian Ocean. The correspondence between winds and currents is most striking here. The monsoon winds change their direction with the seasons and the currents change with the winds.

The NE. monsoon, like the NE. trade wind, sets in motion the NE. monsoon drift (corresponding to the north equatorial currents of the other two oceans), which passes from east to west along the southern shore of Asia. Arabia and east Africa deflect this drift to the south where it joins the movements of the surface water in the south Indian Ocean. In the northern summer, the wind system is reversed and the

SW. monsoon pushes the water eastwards. Deflection near farther India causes it to bend southwards to join the south equatorial current of the Pacific Ocean. The absence of the

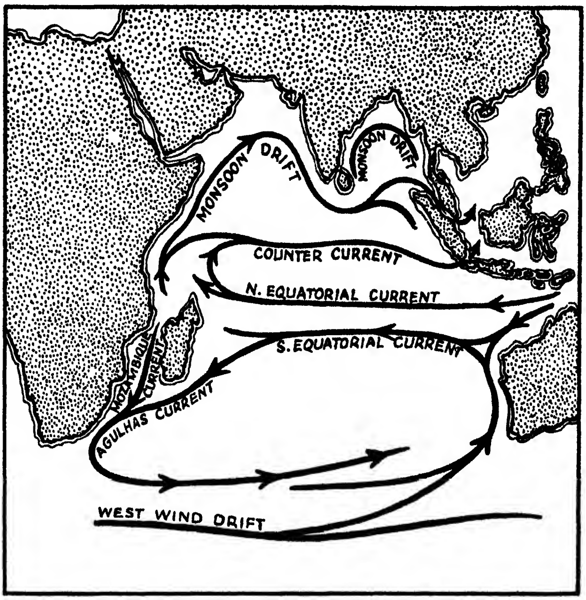

FIG. 58. Currents of the Indian Ocean

equatorial belt of calms in the Indian Ocean, during this season, accounts for there being no counter-current.

Ocean currents are important in many respects. They influence trade routes by sea, they affect the climate of land areas near which they circulate, and they give rise to thick fogs when warm and cold currents meet as in the case of the Grand Banks off Newfoundland. A warm current warms the air above it, which in its turn warms the shores along which it flows, and a cold current lowers the temperature of the coastal lands. Thus the Gulf Stream is responsible for the comparative mildness of the west European climate, while the cold Labrador current, like a cold wall, keeps close to the Atlantic coast of North America and chills the coastal regions.

It is interesting to realize the very important part that the ocean plays in the physical economy of the world. The ocean, being the final destination of rivers, is the great reservoir for the water-supply of the earth. It helps to create great pressure-differences which regulate the wind systems and the precipitation in different regions of the world. The surface currents are of considerable importance in determining the routes of sailing vessels, and in affecting the climate of the lands by the coasts of which they pass. The ocean serves as the great repository for sediments brought down by rivers and for the consequent building up of new lands. It acts as a barrier to plant and animal migrations, and though in olden times it was a barrier also to human migrations, it has in modern times become rather a highway of commerce, so that immigration from and emigration to countries overseas is easier and more common than by land; and, like the river of old, it is a uniting force, facilitating intercourse among the nations of the world.

Chapter III

THE ATMOSPHERE

1. THE ATMOSPHERE

THE Earth is a large central solid mass, the **lithosphere,** surrounded by an inner liquid sphere, the **hydrosphere,** which, however, does not completely envelop it, and an outer gaseous envelope, the **atmosphere.** In the preceding pages, we have treated of the lithosphere and the hydrosphere, and have presented a fairly complete idea of conditions prevailing on the land and water surfaces, particularly in their relation to the interests and activities of man. We shall now turn to the atmosphere, without which indeed life on the Earth would be impossible, for all living creatures need air to breathe. The air is further useful in quite a number of ways. Without air, sound could not be transmitted and the Earth would be a region of eternal silence without so much as even a whisper; the atmosphere acts as a screen against the Sun's light and heat; without it to hold moisture, there could be no rainfall; no snowfall; no animal life, no plant life; and our Earth would be a dead planet like the Moon.

This gaseous envelope surrounds the Earth in a covering which extends above the land and water surfaces to a height of at least 100 miles; it may extend to 200 miles; no one knows exactly, for exploration of the atmosphere has only so far been possible to the height of about eight miles. It is known, however, that the air becomes increasingly rarefied with height. Air being exceedingly elastic and compressible, the bottom layers are pressed down by all the air above them, and the air nearest the surface is therefore the densest. At higher levels, the pressure is less and the density is low, so that it is difficult to breathe easily; and it is for this reason that explorers who attempt to climb to the top of high mountains like Mount Everest carry special apparatus to supply oxygen for breathing in the rarefied air of those high regions.

Composition. The composition of the atmosphere near the surface of the Earth is practically the same all over the globe, except for the varying amount of water-vapour and solid matter present therein. The chief components of air are the two gases, oxygen and nitrogen, present roughly in the proportion of 1 to 4. Other gases like **argon, carbon dioxide** and **hydrogen** are also present in very small quantities. Oxygen is the active principle of life which makes respiration possible for animals and plants; but as it would by itself be too strong, nitrogen dilutes and tones it down. The gaseous elements that compose air form a mechanical mixture and not a chemical compound, so that each constituent gas retains its own characteristics and independence of action. The carbon dioxide, which is present in about 3 parts in every 10,000 parts of air, is the chief food of plants which split it up into carbon and oxygen, retaining carbon for their growth and restoring oxygen to the air. Water-vapour is present in varying quantities, generally not less than 1 per cent. Water is always being evaporated, sometimes rapidly, sometimes slowly, into the air which holds it in suspension till it is condensed into rain, mist, dew or some other form of moisture. The capacity of air to hold water-vapour varies with its temperature. Generally, 1 cubic foot of cold air at 32° F. can hold only about 2 grm. of water-vapour, but at 50° F. the quantity increases to about 4 grm.; a temperature of 68° F. enables the same quantity of air to absorb about 7·5 grm. of water-vapour and hot air at 86° F. still further raises its capacity to about 13 grm. Thus warm air holds a great amount of water-vapour, a part of which it gives up if it is cooled to a lower temperature. It must be remembered that besides these gaseous constituents, there are present in the air countless tiny particles of solid matter, dust. Wind-storms sweep up this fine dust from the ground; smoke supplies small carbon particles; volcanoes shoot forth clouds of dust; and meteorites, too, contribute their quota of dust to our atmosphere.

Each of the constituents of the atmosphere performs useful services, and makes the Earth a suitable abode for man. Light, heat and moisture are essential; without light, no creature can live, and the different amounts of heat and moisture in different parts of the Earth mean different conditions of life for plants and animals. The atmosphere is a very thin screen which receives, reflects and radiates the light of the Sun in different directions, and it is the dust particles in the air that play the most significant role in the scattering of light. Without these particles, only those parts of the Earth would be lighted which receive the light rays directly; the interior of houses even at midday would be dark and dismal; the blue sky would appear black; the stars would be visible in the day time; and there would be no twilight at all, the bright daylight being abruptly changed to black and dreary night. The atmosphere with the dust particles therefore serves a most useful purpose by softening and scattering the light from the Sun.

The heat rays of the Sun in their passage through dry and pure air do not directly heat the air. But the dust and water particles that are present to an appreciable degree in the denser air near the Earth's surface absorb some of these heat rays. The air does not appreciably get heated directly, but once the heat rays reach the Earth, the atmosphere holds them and the heat which is reflected or radiated or conducted from the Earth is not allowed to be lost in space. It is caught and held by the air-screen which, like a warm blanket, retains for our use the heat thus received. Without it, nights would be very cold, all water would be frozen and we should be frozen too. Life without the atmosphere would be impossible.

2. CLIMATE

Climate is one of the most important influences that determine the extent and direction of the usefulness of the different parts of the Earth's surface to man. Climate is one of the principal determining factors as regards the populousness of a region and its capacity to raise particular agricultural, pastoral or manufactured products, and it has an important bearing on the character of the people, their forms of government and their activities. Indeed, climatic control is one of the most characteristic aspects of the geographical control of the progress of man, whether past, present or future, as we shall see later on.

Climate is a very complex matter, resulting from several factors which themselves depend on many others. It is referred to, usually, by us as **ab-o-hawa** or **hawa-pani** (air and water). Now the air around us is practically the same everywhere, and good enough to breathe and support life; one may therefore well wonder why it should be regarded as an element of climate. It is not the composition of the air, however, but its conditions that vary with locality and time, and cause differences in the climates of the different regions of the Earth. It may be more heated all the year, or more heated in summer and colder in winter, at one place than at another; besides, air in motion is wind; and at some places winds cool the air, while at others they heat it considerably. Some winds like the south-west monsoon bring rain, while others disperse the rain-bearing clouds. The temperature of the air and its winds, whether general or local, are thus important factors of climate. To these may be added the very important factor of water, that is, of rainfall. The humidity of the air and the amount of sunshine and degree of cloudiness are also elements; but it will have been seen that temperature and rainfall are the two most important factors that go to make up the climate of a place or a region.

Climate must be carefully distinguished from **weather.** It is not the **daily changes** in the temperature or humidity, or velocity and direction of winds, or in rainfall with which we are concerned when we speak of the climate of a place. We refer, rather, to the **general** conditions of these matters at that place. These conditions not only vary from day to day and season to season, but also from year to year. To get a general idea of the weather conditions, therefore, we take the average for a number of years, say, fifty; and it is this average weather that is called climate, the daily or periodical variations in any one year being regarded as departures from the normal. Thus, for the season June to September of 1935, the actual rainfall departed from the normal by $-1 \cdot 9$ inches in Bombay, $+3 \cdot 1$ inches in the Central Provinces, $-2 \cdot 9$ inches in Sind, and $+5 \cdot 2$ inches in Madras.

3. TEMPERATURE

The temperature of the air at any place depends on many factors, the most important of which are (i) **latitude,** (ii) **altitude,** and (iii) **distance from the sea.**

Latitude. The amount of heat received by any portion of the Earth's surface is determined, as we have seen in a previous chapter, by the duration of sunlight and the distance from the Sun, but mainly by the angle at which the Sun's rays strike the Earth. This will be evident from Fig. 59.

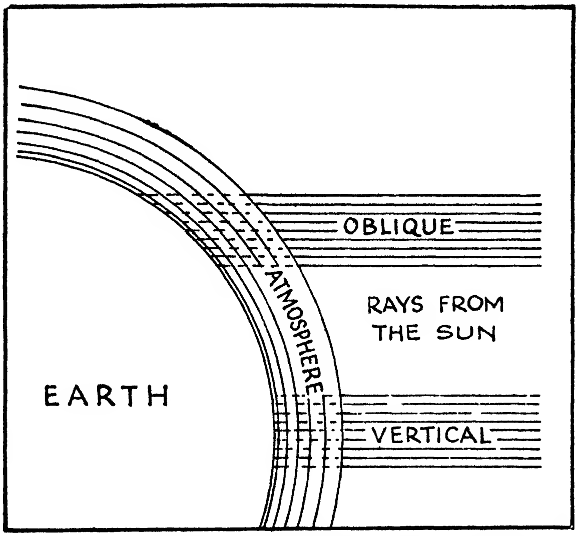

FIG. 59. Insolation by vertical and inclined beams

Oblique rays are spread out over a much larger surface than vertical rays ; moreover, the former have to pass through a greater thickness of the atmosphere than the latter before reaching the surface, and hence part with a greater quantity of their available heat.

Influence of latitude. We have learnt that the noonday Sun in its apparent journey is exactly overhead at the equator twice a year, at the equinoxes, on 21 March and 23 September. On 21 June, it is vertical at noon over the tropic of Cancer, $23\frac{1}{2}°$ N., and on 22 December over the tropic of Capricorn, $23\frac{1}{2}°$ S. These parallels of latitude are thus the extreme northern and southern limits of the Sun's vertical rays. At every place between these limits, the Sun's rays are vertical twice a year. The zenith distance of the Sun is never very great and its rays are therefore never very oblique. Hence this region, known as the **tropical** or **torrid zone,** is in general a region where the temperature is high all the year round; and as these remarks are more true of the central part of this zone than of any other, the equatorial belt receives the greatest total amount of heat. Beyond the tropics, the Sun is never vertical at any time of the year, and the obliquity of the Sun's rays increases with the distance from the equator. But between the tropics and the polar circles, the altitude of the noonday Sun varies from 90° to 47° in summer and from 43° to 0° in winter. The Sun's maximum altitude in summer in these regions is never very low, and in winter the sun is visible for at least a part of the day. These zones are therefore called the **temperate zones** where the summers are warm, but not so hot as in areas between the tropics, and the winters are cold, but not so cold as in the lands in the **frigid zones** beyond the polar circles, where the Sun has an altitude varying from 47° to 23½° in summer and is quite invisible in winter, and where therefore the cold is very intense and temperatures are low throughout the year.

Thus the angle at which the Sun's rays strike the surface of the Earth not only varies from day to day, but also from sunrise to sunset. At sunrise, they strike horizontally, and the altitude of the Sun is zero. The Sun then ascends in the heavens and reaches its maximum altitude for the day at noon. After this its altitude decreases till it again becomes zero at sunset. The length of the day is therefore also of great importance in determining the temperature. The days lengthen in summer and shorten in winter, and this increase or decrease varies with latitudes. The longer days of higher latitudes more than compensate for the greater obliquity of the Sun's rays, and the total amount of heat received from the Sun is greatest, not where the Sun attains its maximum altitude, but in higher latitudes which have longer hours of daylight.

Latitude is thus a very important factor in regard to temperature. Generally it may be said that with increasing latitude the temperature becomes lower, but its range, that is, the difference between the average maximum and minimum or summer and winter temperatures, becomes greater. The following figures well illustrate the influence of latitude.

INFLUENCE OF LATITUDE ON TEMPERATURE

Place	Latitude	Temperature in degrees Fahrenheit			Annual mean temperature in degrees Fahrenheit
		Hottest month	Coldest month	Range	
Bombay	18° 55′ N	84·6	74 5	10·1	79·3
Lisbon	38° 45′ N	70·0	50·8	19·2	60·0
Sydney	33° 50′ S.	72·0	53·0	19·0	62·5
London	51° 30′ N.	64·0	38·0	26·0	50·0

Altitude. Were latitude the only determining factor, all places on the same parallel of latitude would have the same temperature. But this is not so. Agra and Darjeeling are in the same latitude, 27° N., but their temperature conditions are distinctly different, as will be seen from the table below. The reason is not far to seek; the former has a much lower elevation above sea level than the latter. That altitude lowers temperature is a fact well recognized, and taken into consideration in the establishment of hill stations in our country. The heat on the plains in summer is trying, particularly to Europeans

INFLUENCE OF ALTITUDE ON TEMPERATURE

Place	Latitude	Altitude in feet	Temperature in degrees Fahrenheit			Annual mean temperature in degrees Fahrenheit
			Warmest month	Coldest month	Range	
Agra	27° N.	555	94·0	60·0	34·0	78·4
Darjeeling	27° N.	7,376	61·5	40·5	21·5	52·7
Bangalore	12° 57′ N.	3,021	79·9	67·5	12·4	72·8
Mangalore	12° 52′ N.	65	83·9	78·2	5·7	70·6
Simla	31° 6′ N.	7,224	66·9	38·8	28·1	55·1
Lahore	31° 33′ N.	702	93·0	53·0	40·0	74·7

who are accustomed to the much lower temperatures of their own homes in higher latitudes, and the hills provide a pleasant change. Simla, Naini Tal, Mussoorie, Darjeeling, Ranchi, Pachmarhi, Mahabaleshwar, Matheran and Ootacamand, are well-known hill stations in India.

The air is heated chiefly by contact with the warm earth. The surface layer becomes heated by conduction and expands, that is, becomes rarefied and lighter than the surrounding air. It therefore rises and is replaced by cooler air from above. This air in its turn is heated and rises. In this way a thick layer of warm air is formed near the surface of the Earth. But at a distance from the surface, the air does not get heat by conduction, since the heated air in expanding and rising loses heat. Besides this, other factors have also to be taken into consideration in examining the relation of altitude to temperature. The upper layers of the atmosphere are more free from dust, invisible water-vapour and carbon dioxide and are less dense than the lower ones. The Sun's rays, therefore, have to part with comparatively less heat, especially as they have to pass through a less thick layer of the atmosphere before reaching elevated surfaces. The amount of heat received on such surfaces is consequently greater, but so also is the radiation of the heat received, which goes on rapidly for all the twenty-four hours. The result of all these influences is that the temperature of the air on mountains and plateaux is lower than on the plains below, and the average lowering of temperature has been observed to be 1° F. with every 300 feet of ascent above sea level.

As a result of recent investigations it has been found that this lowering of temperature with altitude does not continue beyond about eight miles; the air temperature at greater heights remains nearly the same, about 70° F. This outer atmosphere where temperature variations are not possible has sometimes been called the **isothermal layer**; but the term does not correctly represent the facts, because in this outer envelope, the temperature differences do not correspond to heights above the surface; the temperature layers are almost vertical. The atmosphere, therefore, is now divided into two parts on the basis of temperature; an outer part called the **stratosphere** where there is no change of temperature, and an inner part called the

troposphere which shows a regular correspondence between the fall of temperature and height. There is no definite height level, sometimes called the **tropopause,** where the troposphere ends and the stratosphere begins. It varies with the temperature and other conditions on the surface in different parts of the Earth, but it may be taken as being about four to twelve miles above sea level. Aeronauts are constantly making attempts to climb higher into the stratosphere, and their observations seem to suggest that even in the stratosphere there is no complete absence of atmospheric changes, and that the changes that do take place there have some influence on the temperature and pressure of the air nearer the surface. But this is a problem on which there has yet been little research, and no generalizations of value have been reached; but the work is, nevertheless, of importance as it indicates other lines of research.

Snow-line. Temperature, thus, falls with latitude and altitude. The higher we climb up a high mountain or the farther north or south we go from the equator polewards, the colder becomes the air, until at last we reach a level where snow and ice are met with, and where the heat of the Sun even in summer is insufficient to melt the snow. Combining the two influences, it is evident that in lower latitudes, the region of perpetual snow and ice is reached at a greater height than in higher latitudes. At the equator, the **snow-line,** or limit of perpetual snow, lies at an altitude of about 16,700 feet; on the Indian side of the Himalayas, it is at about 12,500 feet; in the dry eastern Caucasus, at about 11,500 feet; on the Alps at about 9,000 feet; and at 70° N. it is at sea level.

Sea influence. Besides these two factors, there is yet another important influence which affects temperature in a remarkable manner. To escape the summer heat of the plains, people resort to the seaside, since it is recognized that the sea exerts a cooling influence on summer temperatures. Even a few miles make a difference. Surat, distant only about twelve miles from the mouth of the Tapti, is distinctly warmer in summer than the villages of Dumas and Hazira at the mouth of the river. But winter produces just the opposite effect; the sea raises the temperature of the lands near it. Thus, though Bombay has the same latitude and is at a lower altitude than Ahmednagar, it has almost the same temperature in summer and a considerably higher temperature in winter. In summer the sea influence at Bombay lowers the temperature, and so does the high level at Ahmednagar, but in winter,

INFLUENCE OF THE SEA ON TEMPERATURE

Place	Latitude	Altitude in feet	Temperature in degrees Fahrenheit			Annual mean temperature in degrees Fahrenheit
			Warmest month	Coldest month	Range	
Bombay	18° 55′ N	37 0	84 6	74 5	10 1	79·3
Ahmednagar	19° 5′ N	2,152	83 8	67 1	16·7	75 0
Patna	25° 37′ N	183	88 0	60 8	27 2	77 1
Benares	25° 18′ N	267	91 3	60 0	31 3	77·2
Allahabad	25° 26′ N	309	92 5	59 5	33 0	77 3

the sea influence raises the temperature of Bombay and the high level lowers that of Ahmednagar. The annual range is therefore much lower at Bombay. The temperature statistics of the towns in the plains of the Ganges reveal the same effects of the influence of the sea. As we proceed inland along the plains from Calcutta, the summer temperatures rise and the winter temperatures fall, making the range greater.

The causes of this influence of the sea are very clear. The specific heat of water is very high compared with that of land. Water is a bad conductor of heat ; its transparency and mobility allow the rays of the Sun to penetrate deeper into it. Hence the same amount of heat produces a greater rise in temperature on land than on water. But, for the same reasons, in cooling, it is the land which radiates its heat more quickly than water. Thus, in summer the land surface and the air above it have a higher temperature than the sea and the air above it ; but in winter, the land is colder, and the warmer air over the slowly cooling sea imparts some of its warmth to the adjacent country.

Proximity to the sea therefore lowers the temperature in summer and raises the temperature in winter, so that the annual range of temperature is less near the sea than at places inland. Such climates are called **equable** as distinguished from **extreme** or **continental** climates, where the seasonal fluctuations are very pronounced. The range of temperature at a place is very low if it is surrounded on all sides by a large sheet of water, that is, if it is on a small island ; it is greater if it is on the coast. We may therefore distinguish between the **oceanic** or **insular,** and the **marine** or **coastal** or **littoral** types of equable climates. It must be remembered, however, that latitude also influences the range, and therefore, given equal altitudes and equal distance from the sea, the range is greater in higher than in lower latitudes. Thus Bombay has a lower range than Lisbon, or London, and a greater range than Colombo or Batavia.

Other factors. Besides these three chief factors, there are others which also help to determine temperature. The **direction of prevailing winds** is of considerable importance in higher latitudes where the range between the summer and winter temperatures is very great. **On-shore** winds modify the conditions on the land, while **off-shore** winds produce but little influence. The south-west monsoon wind thus affects Mangalore more than Madras. The temperature statistics for London and Bristol also reveal the same influence of off-shore and on-shore winds. Further, winds produce variations according to their place of origin; a land-wind is hot in summer and cold in winter, while a sea-breeze is quite the reverse.

Ocean currents sometimes exercise an important influence on the climate of the lands along which they flow. The lands are warmed or cooled by air movements according as the currents are warm or cold. Thus the climate of Great Britain is considerably warmed by the warm **Gulf Stream Drift,** and the south-western coast of Africa is chilled by the Benguela current. The **slope of the land** also often exercises a powerful influence on the warmth of a place. In the northern hemisphere, south-facing slopes receive the Sun's rays more directly than north-facing slopes, and are consequently warmer. The **excessive** cold of Siberia is largely due to the fact that the country slopes northward towards the Arctic Ocean, that is, away from the Sun.

The **direction of the mountain ranges** affects the temperature by keeping off either cold or hot winds. The rapid alternations of heat and cold in central Canada are mainly due to the absence of protecting mountain ranges in the north. The mighty barrier of the Himalayas protects the plains of India from the cold north winds, and the Alpine barrier similarly protects the Riviera, which has the further advantage of being a steep south-facing slope.

The **soil** also sometimes becomes a factor of some importance in regulating temperature. Absorption and radiation of heat by loose sandy soils like those of the Punjab go on at a more rapid rate than in compact clayey soils like those of Bengal, and give rise to greater extremes, daily or seasonal according to circumstances. In sandy deserts, in the same way, the high daytime temperatures contrast greatly with very low temperatures during the nights. **Vegetation,** by retarding absorption and radiation of heat, helps to moderate temperatures, which thus vary but little in dense tropical forests. **Clouds** have a similar effect, so that a cloudy day is cooler, and a cloudy night is warmer than would result from a clear atmosphere. Condensation sets free a large amount of latent heat, and accordingly **rain** is accompanied by a rise of temperature, while brisk evaporation is attended by a definite fall.

Temperature records. Temperature is estimated by means of thermometers, of which there are two commonly in use. The **Centigrade** thermometer, with 0° as freezing-point and 100° as boiling-point, is usually used for scientific purposes; and the **Fahrenheit** thermometer, with 32° as freezing-point and 212° as boiling-point, is used for ordinary and meteorological purposes. Since 100° on the Centigrade scale corresponds to 180° on the Fahrenheit scale, the conversion from one scale to another can easily be made if due allowance is made for the 32°. Thus 10° C. corresponds to $\left(\frac{9}{5} \times 10\right) + 32°$, that is, 50° F.; 20° C. to 68° F., and 30° C. to 86° F.

At various meteorological stations in the different parts of the world, careful thermometer readings are taken each day, and accurate records of these are maintained. Specially constructed thermometers register the maximum and the minimum temperatures of the day, and the difference between their readings gives the daily average or mean temperature, while the average of these readings gives the daily average or mean temperature. The monthly average is obtained by taking the average of the mean daily temperatures for the month, and such mean monthly temperatures give us the mean annual temperature.

It is, however, not the **quantity** of heat received that determines actual temperatures, as these really depend on the balance between the amount of heat received and that lost by radiation. Radiation being continuous for all the twenty-four hours, it may often happen that the amount of heat lost may continue to exceed the amount received even after sunrise. Similarly, even after the Sun has passed its maximum altitude for the day, the amount of heat received may continue to exceed the amount lost by radiation, and the maximum temperature for the day may therefore be reached some hours after midday. Similar reasoning explains why the lowest temperatures for the year are found in the northern hemisphere in the month of January, and the highest temperatures usually occur in the month of July, though for places near the tropics, June (as at Lahore), and for places within the tropics (such as Bombay), even May may often be the warmest month. In the southern hemisphere, the reverse is of course the case.

Isotherms and temperature maps. All places having the same average temperature can be joined by a line shown on a map, as all places having the same latitude are joined by a parallel of latitude, and all places having the same elevation above sea level by a contour-line. Such temperature lines are called **isotherms**. But owing to great differences in relief over the Earth's surface, an isothermal map showing actual temperature conditions is very confusing and complicated. Usually, therefore, the effect of altitude upon temperature is ignored and the isotherms show, not **actual** temperatures but 'temperatures reduced to sea level'; that is, what the temperatures would be if all places on the particular lines were at sea level. Thus Bangalore, with an altitude of about 3,000 feet, would not be marked on the isotherm of 72° F. in July, but on that of 82° F. since its altitude lowers the temperatures at the rate of

1° F. for every 300 feet of rise, that is, by 10° F.; and Ootacamund (7,327 feet) is on the July isotherm of (56·9+24·5)° F., that is, 81·4° F.

Isothermal maps may be annual, monthly or daily, showing the average temperature for the year, month or day. But for the study of temperature conditions and seasonal changes on the Earth's surface, by far the five most useful isothermal maps are those for the year, for October and April, and for January and July. An isothermal map may show any number of isotherms, 30° F., 35° F., 40° F. and so on. But the most instructive ones for general study are the isotherms of 32° F., 50° F., 68° F., and 86° F., corresponding to 0°, 10°, 20° and 30° C. Regions below 32° F. are cold, those between 32° F. and 50° F. are cool temperate, those between 50° F. and 68° F. are warm temperate, those between 68° F. and 86° F. tropical and those over 86° F. hot. Thus, it is these isotherms, rather than the two tropics and the polar circles, which give us the real climatic zones, the torrid, temperate and frigid.

A study of isothermal maps (Figs. 60, 61 and 62) reveals the temperature conditions and seasonal changes over the surface of the Earth. Were latitude the only determining influence on temperature, the isotherms would have been parallel to the parallels of latitude; but they are not so. That latitude is, however, a very important factor is shown by the fact that the isotherms have a general east to west trend, that is, they tend to be parallel to the parallels of latitude. Further, **the belt of greatest heat** in all the three maps is in the regions near the equator, and temperature decreases with latitude. An interesting thing to be noticed is that the belt of greatest heat does not remain constant in position throughout the year. In October and April it is in the region of the equator, where the Sun is vertical at noon; in January, it shifts south of the equator; and in July it shifts north of the equator. With this seasonal shifting of the hot belt, other belts, too, swing northwards and southwards, following the apparent course of the Sun.

The hot belt moves farther northwards of the equator in our summer than it goes south in the southern summer. This is due to the fact that in the northern hemisphere there are large land masses which are quickly heated by the Sun;

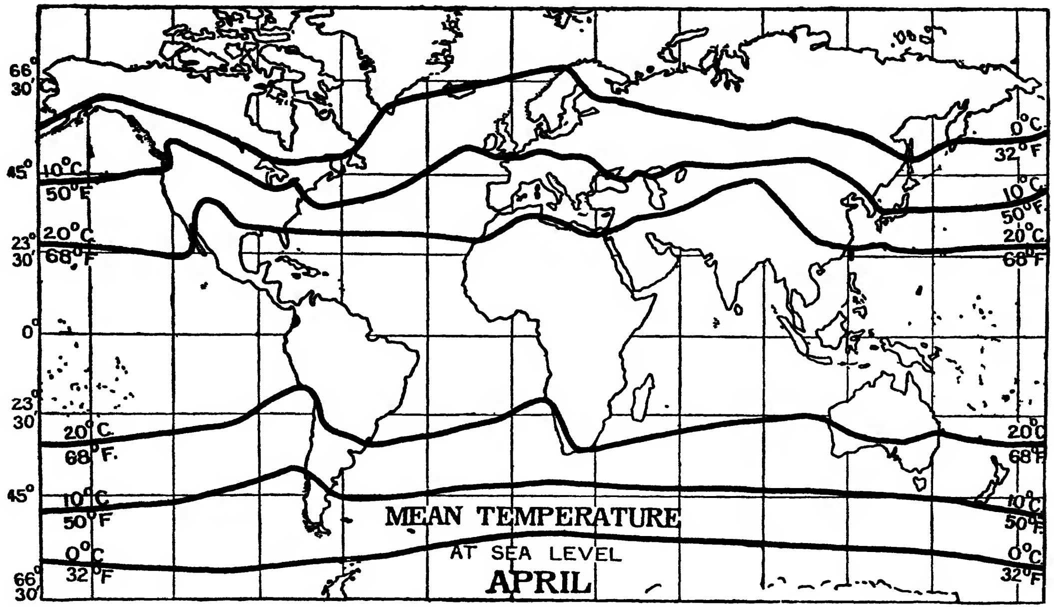

Fig 60 April isotherms

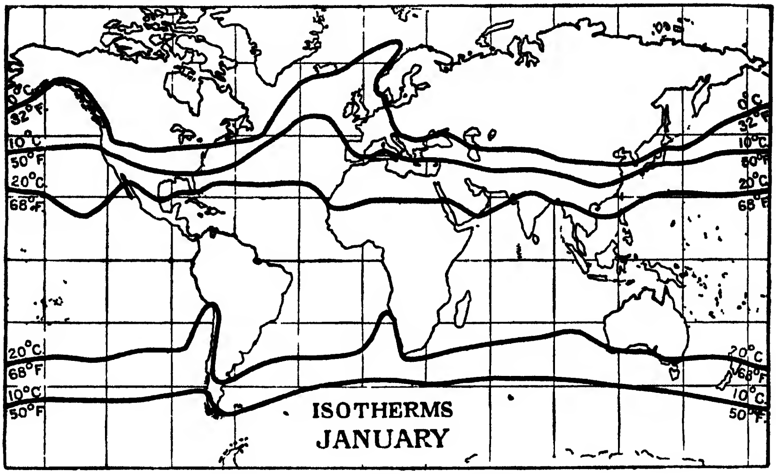

FIG 61 January isotherms

in the south, water predominates, and as it gets heated very slowly, the temperature does not rise to any very high figure before the northward movement of the Sun begins again. The maps further show that the hot belt broadens over the lands and narrows over the oceans, and that isotherms on approaching a land mass bend towards, and on leaving it

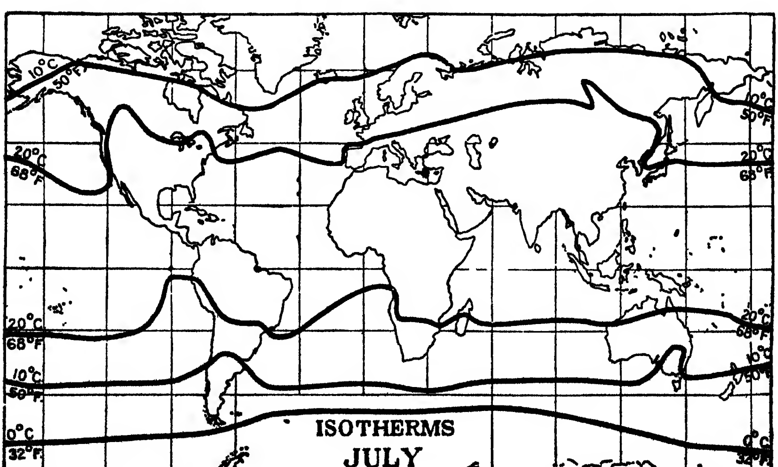

FIG. 62. July isotherms

bend away from the equator in winter, that is in January, for the northern hemisphere and in July for the southern hemisphere. The reverse is the case in summer. These bends of isotherms are clearly due to the moderating influence of the oceans. The absence of this influence creates extremes of temperature in inland continental areas, and at Verkhoyansk in Siberia, known as the **cold pole,** the temperature drops in winter to $-40°$ C. The influence of ocean currents can also be perceived in the great and sudden bends in the isothermal lines just before they touch the western coasts of the southern continents.

4. ATMOSPHERIC PRESSURE

The air has weight; a cubic foot of air weighs about 1·25 oz., and the atmosphere therefore exerts pressure upon the surface of the Earth. This pressure, the elastic force of the air, acts outwards in all directions; for if we think of a very small portion of still air, it is apparent that it is at rest, because the upward elastic force must be counterbalanced by the downward force of the air above it. Atmospheric pressure is measured by a simple instrument, the **barometer.** Devised by Torricelli, a pupil of Galileo, the barometer consists of a glass tube about 33 inches long, open at one end, filled completely with mercury and inverted in a bowl of mercury. On inversion, part of the mercury in the tube runs out into the bowl, but a column of mercury about 30 inches high remains in the tube. The pressure of the atmosphere outside is counterbalanced by the weight of the mercury column. Any increase in the pressure of air will force a little more mercury up the tube; any decrease will lead to a little of the mercury in the tube running out into the bowl. The mercury column thus rises or falls according as the air pressure is greater or less; and the height of the mercury column in inches or in millimetres gives us the measure of atmospheric pressure. The normal pressure at sea level is about 30 inches or 760 millimetres, which gives us about 14¾ lb. per square inch; more than this value is termed **high pressure,** and less, **low pressure.**

As atmospheric pressure is due to the weight of the superincumbent column of air at any point, it is clear that it must decrease with altitude. The rate of this decrease is not uniform, since, as we go higher and higher, there is not only a smaller height of the column of air above us, but the air becomes rarefied and therefore less heavy. The temperature of the air also affects its density, and differences in pressure cannot be explained only by difference in altitude without taking temperature differences into account in addition. Ordinarily a rise of about 900 feet in height corresponds to a lowering of the barometric reading by 1 inch ; this is true for a mean pressure of 29 inches and a mean temperature of 30° F. The rate, however, decreases with a decrease in the temperature and increase in the pressure. The barometer is thus a very useful instrument for the measurement of heights of mountains, balloon ascents and aerial flights. If the barometer at one station reads 29 inches and at a higher station 27 inches, and if the temperatures at the two stations are 75° F. and 65° F. respectively, the fall of 2 inches would not correspond to a height of 1,800 feet, but to some higher figure. Certain corrections for standard temperature and pressure would raise the figure to about 2,000 feet. At about 18,500 feet, that is, about 3½ miles, the air pressure is only about half that at sea level. Half the atmosphere (by weight, not by volume) is thus contained in the concentric layers of air above the surface of the Earth up to this height. Another 3½ miles of such concentric layers above contains about one-fourth and yet another 3½ miles above, about one-eighth. The atmosphere thus extends upwards in a very rarefied form to a very great height indeed.

Pressure and temperature. Pressure varies with altitude. But it is not the same at all places at the same level nor at all times of the year at the same place. Variations are considerable from day to day and from place to place, and are largely brought about by differences of temperature. Take a region *A* (Fig. 63) which is warmer at the surface than the surrounding regions *X* and *Y*. The heated air on the surface *SS* in region *A* expands and a large weight of air accumulates at the higher level *HL*, where the pressure becomes higher than that on the same level in regions *X* and *Y*. These pressure-differences will set up currents of air over *HL* from *A* to *X* and Y, and create a low pressure region at the surface in *A*. This air movement leads to the accumulation of air in X and Y which will now tend to be high pressure regions. The cooler and now denser air over the surface in X and Y will thus flow towards A to take the place of the heated air which rises from

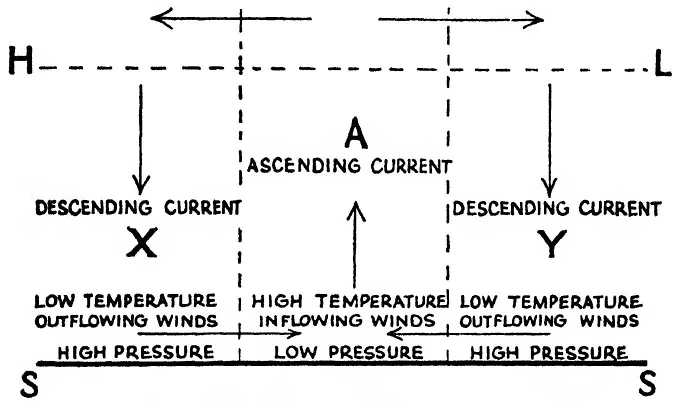

FIG. 63. Temperature, pressure and air currents

the surface there. In this way, where there are temperature differences in adjoining regions, there will be an upward current of air in the warmer region and a downward current in the colder one; at the surface there will be an air-movement from the colder to the warmer region, and at higher levels from the warmer to the colder; a complete system of convection currents is set up. The surface pressure will be low in the warmer region and high in the colder region. Higher temperatures are thus associated with low pressure, an upward current of air and inflowing winds; and lower temperatures with high pressure, a downward current of air and outflowing winds.

5. WINDS

The relationship between temperature and atmospheric pressure suggests a definite system of air in motion, or winds, over the Earth. The temperature decreases from the equator towards the poles and the pressure should therefore increase polewards, and surface winds should blow from the poles to the equator, where we expect rising, convection currents. The actual phenomenon observed is, however, not quite that which is suggested above. There is a low pressure belt at the equator; there are the convection currents rising there; but the high pressure belts are found, not at the poles, but in middle latitudes, 30° to 40° north and south, where the air is settling down and we have downward currents of air. The winds do not blow directly from north to south from the high-pressure belts to the equator, but obliquely, the north winds becoming north-east and the south winds becoming south-east. But mere differences in temperature are not sufficient to account for these variations from the conditions which would be deduced from the above explanation.

Rotation of the earth and deflection of winds. The Earth is not stationary; it rotates from west to east. A wind-current, once started, however, tends to continue blowing in the same direction, even though the surface beneath it is moving from west to east, with the rotation of the Earth; it thus appears to blow from a different direction, relatively to the Earth's surface, and is said to be deflected on account of the rotation. A wind starting from the North Pole has the northern hemisphere rotating to its left, and in blowing over the surface, it would therefore be deflected to the right. Similarly, a wind in the southern hemisphere is deflected to the left. To realize this deflexion, we must remember the fact that in moving equatorwards the wind passes from a region of less velocity to regions of increasing velocity so that it lags behind and is deflected to the west. In the same way, it will be clear that winds blowing towards the poles, that is, from regions of greater to regions of less velocity, are deflected to the east, though the deflexion is still to the right in the northern and to the left in the southern hemisphere. The amount of the deflexion increases with latitude and at the equator itself there is no deflexion. This law governing deflexion is known as **Ferrel's law.**

The low pressure area at the equator has ascending currents of air which give rise, as already explained, to winds in the upper atmosphere blowing polewards. These winds are deflected to the east more strongly than surface winds because there is decreased friction in the upper air, and by the time they reach regions between latitudes 30° and 40° N. and S., the deflexion has converted them into westerlies; so that the upper air there undergoes no further deflexion, and moves in a great swirl from west to east. The upper air in these latitudes thus gets compressed, and having become cooler, sinks and produces high pressure at the surface. We thus have the belts of maximum pressure, not at the poles, but in latitudes 30° to 40° N. and S., and winds blow from these high pressure regions towards the equator and towards the poles. At about latitudes 60° N. and S. we again have a low pressure belt, probably due to the low saturation point of the air there, while at the poles there are high pressure belts again due to low temperatures. There are thus definite alternate belts of low pressure and high pressure in the two hemispheres, but the phenomena are yet too complex to be completely understood and accounted for.

Pressure belts. The equatorial low pressure belt known as the **doldrums** is a region of rising currents with calms at the surface. The freshness and buoyancy which air movement brings, is absent, and one feels rather heavy and depressed; the waters of the ocean are comparatively still and the clouded skies of the equatorial region appear threatening. The high pressure belts in sub-tropical latitudes are known as the **horse latitudes.** There are descending currents of the air in these regions and there are calms at the surface known as the **calms of Cancer and of Capricorn**: and the high pressure makes them dry.

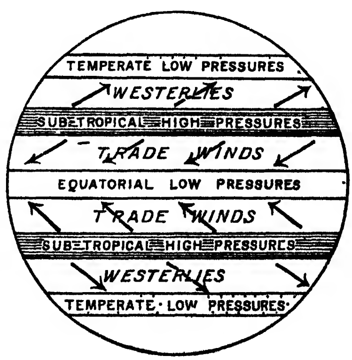

FIG. 64. Pressure belts

Planetary winds. The chief wind system of the Earth therefore has its origin in the horse latitudes: the winds blowing equatorwards are known as the **trade winds**, and are north-east in the northern and south-east in the southern hemispheres; and those blowing polewards are respectively south-west and north-west. These latter winds, as they move in a direction opposite to that of the trade winds are, in a way, anti-trade winds; but as, in their passage towards the poles, they become almost westward, they are now generally known as the **westerlies** in the northern hemisphere and the **brave west winds** in the southern hemisphere. The polar winds are but little known; they are, however, probably more or less north-east and south-east respectively in the northern and southern hemispheres. The trade winds blow steadily and regularly from the calms of the horse latitudes to the equatorial calm. They seemed to tread out a path in the seas for sailing vessels by their great steadiness and regularity, and mariners called them 'tread' winds; but 'tread' has been altered to 'trade', and they are now known as trade winds. The westerlies vary considerably in strength and direction.

This wind system, and the pressure belts on which it is based, shifts northwards and southwards in keeping with the swing of the equatorial hot belt on which the whole system primarily depends. Such a circulation of air would be established on any planet like the Earth which rotates on its axis and which has an atmospheric envelope; and for this reason the winds are known as **planetary winds.**

Land and sea breezes. Temperature differences which are primarily responsible for pressure differences, which in their turn develop wind systems, are, however, not solely due to latitude differences, but also to the distribution of land and water on the surface of the Earth. Land is heated more quickly

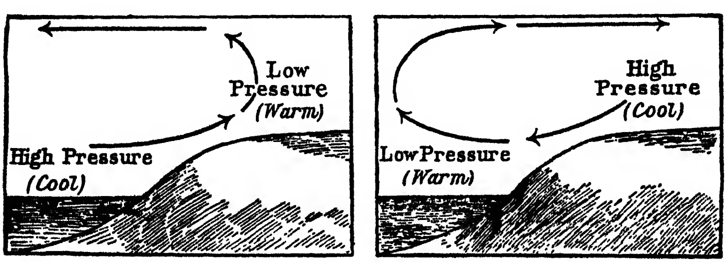

FIG. 65. Land and sea breezes

than water, but also cools more quickly. Near the sea coast, the air over the land is heated during the day-time, while the air above the sea remains relatively cool. The land becomes a low pressure area and the sea a relatively high pressure area. A wind, therefore, often spoken of as a **sea**

breeze, blows from over the water to the land and is felt more particularly at midday and in the afternoons when the pressure difference is greatest (Fig. 65). During the evenings and nights, the land with the air above it cools rapidly, while the sea with the air above it remains relatively warm ; the high and low pressure areas are then reversed, and a **land breeze** blows from the land to the sea.

Mountain and valley breezes are similarly set up by the differences in temperature, and therefore of pressure, between the mountain top and the valley below. The mountain winds blow down from the colder mountain top to the warmer valley below at night, and the valley breezes rise from the cooler valley to the warmer mountain during the day. The mountain slope and the greater density of cold air further facilitate the fall of the mountain wind from higher to lower levels.

Seasonal winds. The alternation of day and night gives rise to the winds mentioned above, which are thus local winds having their origin in the topography. The alternation of summer and winter creates a similar phenomenon where large sheets of water and large masses of land are concerned. During the summer, the temperature of the land mass remains high compared with that of the ocean ; the land remains a low pressure area and the ocean a high pressure area. During the winter, the higher pressure is over the land and the lower pressure over the ocean. Hence we have the phenomenon of **seasonal or periodical winds,** the **monsoons** (from **mosum,** a season), which are sea and land breezes on a gigantic scale. Such monsoon winds are conceivable almost everywhere on the surface of the Earth, where land and water masses are close to one another. But it is only when these masses are large, and when the temperature and pressure differences between them are great, that is, when they are in tropical and subtropical latitudes, that the monsoon winds are strong enough to overcome the planetary system of winds and become the prevailing winds in the area. Well-developed monsoons are found in India, farther India, the East Indies, and northern Australia, where the above conditions are fulfilled to a greater degree than elsewhere. In the northern summer, the equatorial belt of calms is shifted to the north ; the south-east trade winds cross the equator, and, being deflected to the right, become south-west winds. At this period, the large land mass of continental India, particularly the north-western portion, has high temperatures with rising air and low pressure. The south-west winds are therefore drawn into this area; they replace the normal planetary north-east trade winds; and, becoming heavily charged with moisture during their passage across the Indian Ocean, give heavy rains to India (Fig. 66). This same wind, as it is drawn inwards towards the

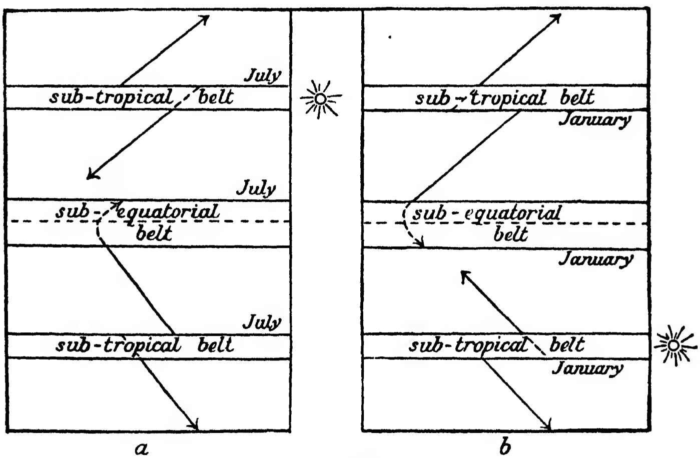

FIG. 66. Periodic winds

interior of Asia, becomes the south-east monsoon of the Far East and brings rain to China and Japan.

In the northern winter and southern summer, the conditions are reversed, and there prevails in India the normal system of the north-east trade wind, which thus becomes, for India, a seasonal or periodical or monsoon wind instead of a regular or planetary wind. The north-east trade wind now crosses the equator, the equatorial hot belt having shifted a little to the south; crossing the equator, it is deflected and becomes a north-west wind. The northern Australian land mass is at this period a low pressure area, and the north-west wind crosses the Indian Ocean and blows over northern Australia as the north-west monsoon. Monsoons on a small scale are developed on the Guinea coast, and also in the Gulf of

Mexico, from which the warm moisture-laden winds penetrate far into the interior giving rainfall to that part of the United States so affected.

Variable winds. We have thus seen that, in the tropical regions, the prevailing winds are planetary or regular, except where they are overcome periodically by seasonal winds. But apart from these periodic variations, there occur now and again many others, which give rise to **variable** or **cyclonic winds.** Local temperature and pressure differences, and the resulting convection currents, are influenced by the Earth's rotation and the swirling movement it imparts; these give rise to certain stormy variable winds. Such tropical cyclones are usually not to be found near the equator, but near the outer limit of the equatorial hot belt as it swings towards the tropics in summer; in the Indian waters, they are frequent in the period of calm about the change of the monsoons; their progression is along a curved path and they often cause catastrophic effects. The **typhoons** of China, **hurricanes** of the West Indies, **tornadoes** of the United States, **whirlwinds** and **simooms** in other regions are but different local names for such tropical cyclones.

In the temperate regions convection does not play a leading part in the formation of cyclones, the cause of which in these areas has not yet been satisfactorily explained. The north temperate zone has lands and seas curiously intermixed, and unequal pressure conditions are established, with the result that the planetary winds of the region are not able to hold sway, and variable whirling winds, **cyclones**, take their place.

Isobars. Just as isotherms connect places on the map having the same temperature, so we have **isobars,** or lines of equal barometric **pressure.** Pressures, too, are corrected to sea level, so that isobars show the actual pressure conditions only over the seas and lowlands. A close arrangement of the isobars indicates a rapid change of pressure, and the **barometric gradient** is said to be steep; when the isobars are farther apart, the gradient is gentle. The force with which the wind blows between any two areas varies with the difference of pressure between them; and the steeper the gradient, the stronger, in general, is the wind, while light winds are associated with gentle gradients.

Cyclones and anti-cyclones. The close relation between temperature and pressure would suggest that isobars should closely follow isotherms ; but though, in general, both run from west to east, isobars sometimes show a more or less concentric arrangement (Fig. 67). The close alternation of land and water in the north temperate zone brings about such an arrangement of isobars more often there than elsewhere, and develops, in place of the planetary winds, variable ones whose directions are much less constant. This is because there are in these areas considerable differences between the daily pressure conditions and the monthly averages. From the horse latitudes to the arctic low pressure area, there is no uniform lowering of the pressure ; the isobars are twisted into circles or ovals, enclosing centres of high pressure or low pressure. These low pressure systems are known as **cyclones,** the high pressure systems as **anti-cyclones.** In a cyclonic arrangement of isobars, the low pressure area is in the centre, surrounded by areas of increasing pressure. The flow of the winds from the high pressure regions outside to the centre is converted into a swirling movement on account of the Earth's rotation ; and the wind direction is more or less parallel to the isobars, but a little curved towards the centre. Therefore, air currents in a cyclone whirl spirally in towards its centre, **anti-clockwise** in the northern hemisphere and **clockwise** in the southern hemisphere. If we stand with our backs to the wind in the northern hemisphere, the lower pressure centre is to our left, the higher pressure centre to our right. The reverse will hold in the southern hemisphere. This relation between atmospheric pressure and the direction of the wind is known as **Buys-Ballot's law.**

A cyclone rarely remains stationary. It generally moves in the direction of the regular wind system in the particular area. Thus in the region of the westerlies, most cyclones move forward eastwards, while in the trade wind regions the progression is usually in a westerly direction. Cyclones do not move at a uniform rate ; in temperate regions, the rate of movement of the centre may be about 20 or 25 miles an hour, while in tropical regions it is about 5 or 6 miles an hour. This rate of progression is of course quite different from the strength and velocity of the wind in the cyclone, which depends on the

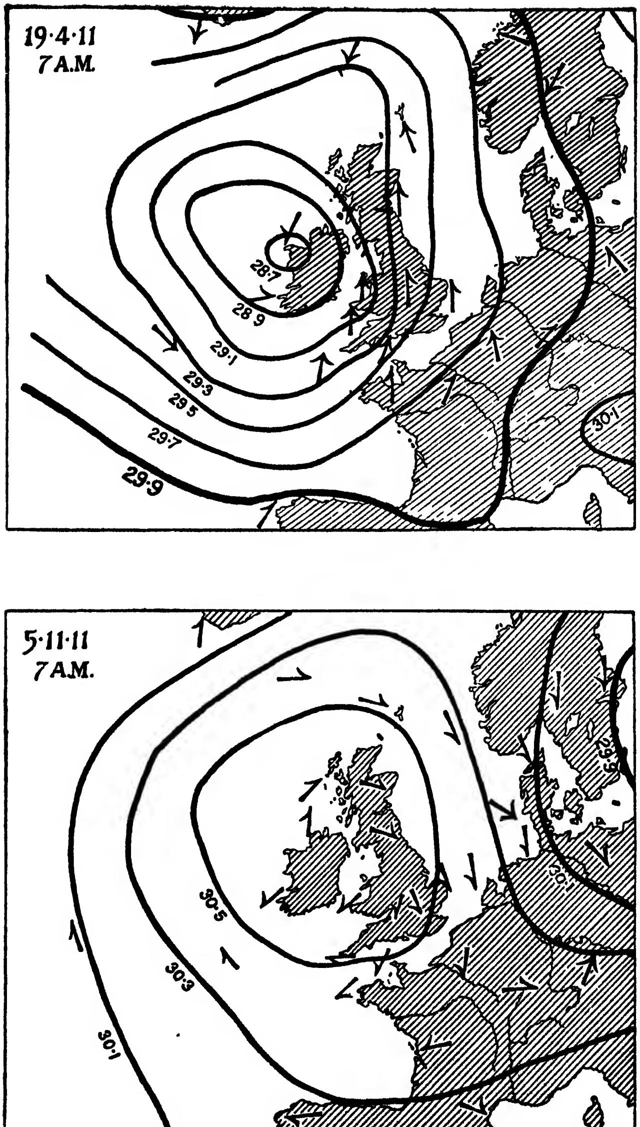

FIG. 67. Cyclone and anti-cyclone

steepness or otherwise of the barometric gradient; the winds in the cyclones of the tropics are often much stronger and more violent than those in the temperate cyclones. The centre of the cyclone, where the pressure is lowest, is not necessarily in the middle, but rather a little behind; the trough is the line through the centre at right angles to the direction of its track, and it divides the cyclone into two parts, the front and the back.

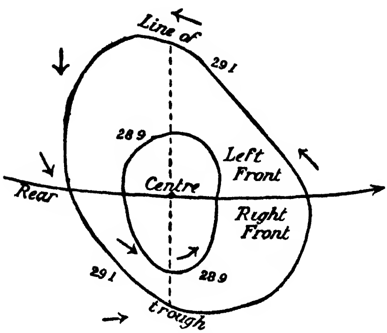

FIG. 68. Diagram of actual cyclone

No satisfactory explanation has been so far devised to account for the formation of cyclones and the phenomena associated with them. A current of air ascending from the surface produces outflowing winds in the upper atmosphere, which, on cooling, sinks to the surface and forms anti-cyclones from which surface winds blow to the cyclonic area. The cyclones thus feed the anti-cyclones at upper levels, and the anti-cyclones strengthen the cyclones at lower levels. This convectional theory is satisfactory enough for tropical cyclones; but it cannot be accepted for temperate cyclones, since it does not explain their great frequency in the north Atlantic, particularly in winter, and the relatively low temperature at their centre does not theoretically develop cyclonic conditions.

Pressure maps. It is instructive to study the mean pressure at sea level for January and July (Fig. 69). In our winter, we have high pressure areas over the cold land and low pressure areas over relatively warm seas; in the southern hemisphere, the conditions are just the reverse. In our summer, high temperatures and low pressures are found over the land in the northern hemisphere; but in the southern hemisphere, owing to the absence of large land masses, while there are small high pressure areas in the southern continents, the ocean itself is a high pressure region throughout the whole year, the pressure decreasing towards the Antarctic Circle.

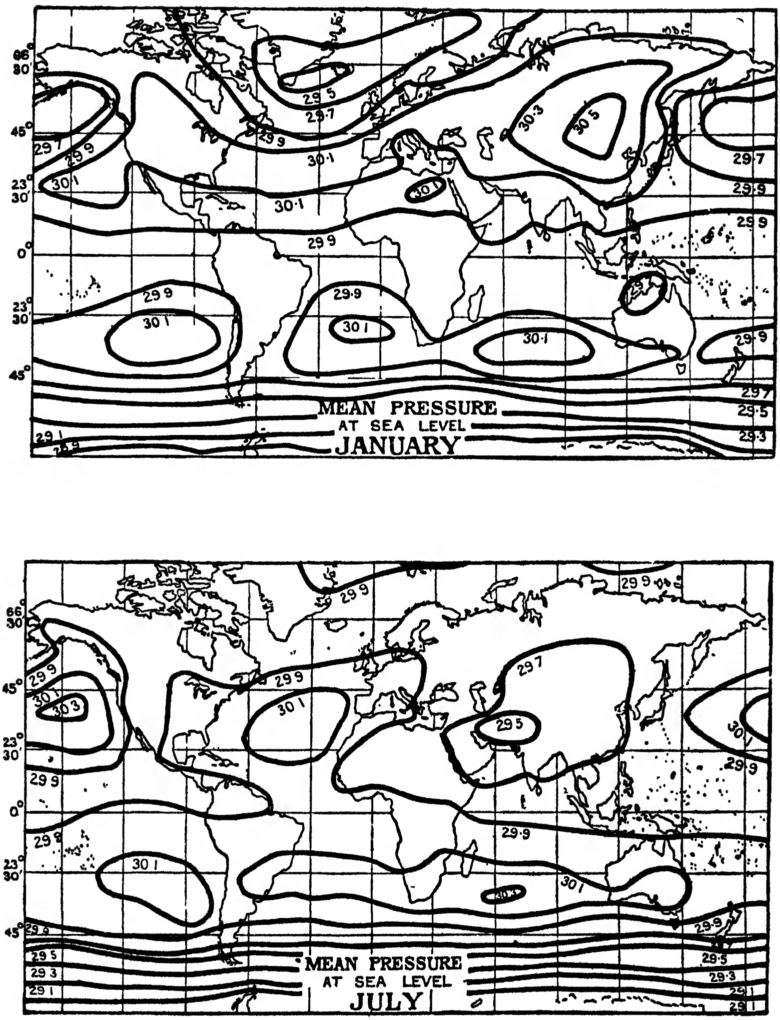

Fig. 69. January and July mean pressures

6. RAINFALL

Humidity. The air always contains water-vapour, but the amount present is not the same for every day or at every place. The amount is greater in the air over coastal regions than over interior lands. The temperature of the air has considerable influence on the amount of water-vapour in it ; on a very hot day, as much as two and a half per cent of the air may be water-vapour ; and its varying amount has a very marked effect on pressure. We feel that the air is dry or moist, not because the actual amount of vapour in the air is little or great, but because the amount is farther from or nearer to the maximum which the air at the particular temperature is capable of absorbing ; similarly, the formation of clouds and rain depends on this proportion of the actual amount to the maximum. The actual amount of vapour present in a cubic foot of air is called the **absolute humidity,** and the proportion of this amount to the maximum amount possible is called the **relative humidity.** Humidity is usually measured with the assistance of **wet** and **dry bulb thermometers.** The dry bulb thermometer is just an ordinary thermometer, and we obtain from it the temperature of the air ; the wet bulb thermometer has its bulb wrapped in muslin or cotton kept constantly moist. Saturated air will give the same readings on both thermometers ; but if the air is not saturated, evaporation will take place from the moist muslin or cotton and lower the temperature of the wet bulb, and the readings on the two thermometers will differ. The drier the air, the more rapid will be the evaporation, and the greater will be the cooling and the consequent difference between the readings of the two thermometers.

Condensation. Saturation depends on the temperature. Heated air requires a larger amount of vapour for saturation ; cooled air, a smaller amount. If, therefore, air which is not saturated, becomes gradually cooled, it will at length reach the temperature at which the amount of water-vapour present therein will be the maximum that can be held. With further cooling, the amount of vapour is greater than that which the air can retain, and the excess is therefore condensed. This temperature at which the air becomes saturated and condensation starts is called the **dew-point.**

There are several ways in which the invisible water-vapour is condensed. The water produced by condensation may remain suspended in the air as mist or fog or cloud ; it may be deposited on solid objects as dew or hoar-frost ; or it may fall as rain, snow or hail. Condensation generally requires some nucleus around which the drops of water are formed. The blades of grass and other objects on the ground lead to the deposition of **dew;** but if the dew-point is lower than the freezing point of water, **hoar-frost,** that is, little ice particles, are formed directly. Still air, and unclouded skies, allowing unobstructed insolation and evaporation by day and unimpeded radiation by night, greatly favour the formation of dew, and are characteristic conditions of anti-cyclones. If the air near, but not in contact with the surface is cooled, the condensed vapour remains suspended within the air, and **fog** or **mist** is formed ; and if the air still higher is condensed, a **cloud** is formed. In the lower layers of the atmosphere, the innumerable dust particles and other solid matter present there act as nuclei ; the tiny water particles remain floating in the air as fog or mist or cloud ; but as each such particle acts as a nucleus for further condensation, their weight ultimately becomes too great for continued suspension and they fall as **rain.** Mist is formed of pure water particles and gives us a very wet feeling when we pass through it. It is often found on mountains where valley breezes push up warm air to the cold rock surface or the cold air of the mountains. The water particles in the case of **fogs** are built up around dust and smoke particles more commonly found in industrial towns. The mixing of warm and cold currents lead to the formation of fogs such as those off the Grand Banks of Newfoundland. The melting of drifting icebergs acts in the same way as the meeting of the cold Labrador current and the warm Gulf Stream, and conditions are created which are very favourable for the formation of fogs through condensation.

Clouds are of the nature of mists, but formed high above the surface of the Earth. There are many kinds of clouds, the chief of which are **stratiform, cumulus** and **cirrus,** named after their shape as determined by the manner of their formation. Stratiform clouds are not thick, but have wide extent across the sky as long bars, and resemble fog-like patches interspersed with streams of blue. Cumulus clouds are usually thick clouds on a horizontal base and appear like a number of rounded domes merged together, somewhat resembling steam issuing from a railway engine. Cirrus clouds are whitish, but take brilliant hues at sunset, and are thin, fibrous and feathery.

Cooling of air. The formation of dew, frost, mist, fog, cloud and rain depends upon the cooling of the air and the condensation of vapour into droplets of water. This cooling may take place in many ways; by conduction, by radiation, by admixture with colder air; or it may be the result of a rising current of air. The lowest layers of the air are in contact with the Earth's surface and are cooled at night by conduction; those near enough to the cold surface are cooled by radiation; but cooling and condensation may also be brought about by the movement of the air from a warmer to a cooler region, from sea to land in winter, or from lower to higher latitudes, as well as by the mixing of a warm and a cold air current. But besides these methods of direct cooling, there is the indirect method by which the expansion of air brings about cooling. Ascending currents of air result in a reduction of pressure, with consequent expansion. Such ascending currents therefore usually lead to cooling, condensation and precipitation, and are the most important causes of rain.

Convectional rains. In the equatorial region, the conditions are favourable for heavy rainfall. There we have a low pressure area with an upward drift; the temperature is high; constant evaporation supplies very great quantities of water-vapour to the rising air, the cooling of which gives a very heavy rainfall. With the swing of the equatorial hot belt, the equatorial rain belt also swings to some extent, but the distribution of land and water makes it shift more to the north in the northern summer than to the south in the southern summer. In tropical lands the rainy season is regulated by this movement of the equatorial rain belt. The tropical cyclones pass across these regions, and convection plays a prominent part in the precipitation of rain. In the monsoon lands, rising currents of air are formed over the heated land in summer, and cooler air currents over the ocean are drawn inwards to take their place. The expansion and cooling of these moisture-laden currents give to these regions their heavy summer rainfall. Thus in all these regions, equatorial, tropical and monsoon, convection plays the most important part in the production of rainfall.

Cyclonic rains. Rising air currents are also associated with the centres of cyclones, where there is low pressure. The temperate cyclones, as they pass from west to east in the regions of the westerlies, bring cloudy weather and rain. It is in the front and on the southern portion of these cyclones in the northern hemisphere that we get rain, but in the southern hemisphere rain is associated with the front and the northern portion. The rear of the cyclone has clear skies, and cool, dry and northerly winds. In high pressure areas or anti-cyclones, the descending current of air is warmed by compression; the outflowing winds are dry; the sky is cloudless and clear; heating and cooling proceed unimpeded. This leads to very hot weather in summer and to very cold weather in winter, when sometimes the air near the surface gives up so much heat by radiation that a haze may be formed.

Relief rains. Besides convectional and cyclonic rains, we have a third type—**relief** or **mountain rains.** This is

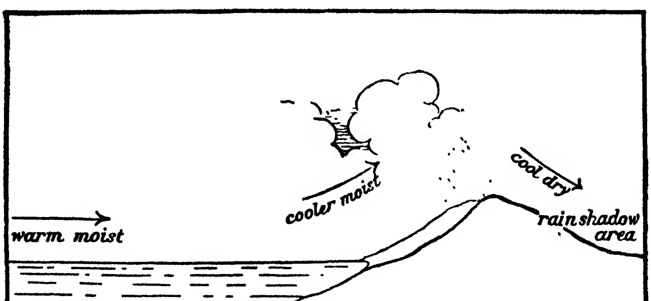

FIG. 70. Relief rain

perhaps the most widespread mode of precipitation. A rising current of air may be due to convection or to the low pressure at the centre of a cyclone; but, more generally, a wind blowing over rising land is made to rise; in rising, it expands and cools; and if the temperature falls sufficiently for condensation, rain results. Condensation, however, sets free the latent heat of vaporization, and thus raises the temperature of the air and the saturation of the dew-point, and retards further cooling. Thus the average rate of cooling is 0·6° F. and not 1° F. for every 300 feet of ascent. The rate of cooling, however, varies, and upper slopes get less rainfall than lower and middle slopes. Again, rainfall is heavier on steeper slopes, for, where the slope is gentle, the condensation will be spread over a larger area. Therefore, when winds blow over land, and their passage is obstructed by mountains, they are forced to ascend the windward slopes, and deposit the moisture they can no longer hold. Condensation being due in this case to the relief of the land, the resultant rains are spoken of as **relief rains** (Fig. 70). It may be noted here that the winds on passing to the leeward side of mountains, descend, are warmed by compression, have their saturation capacity increased and so become dry winds, causing rapid evaporation rather than any considerable precipitation. Thus this leeward side receives little rain and remains a relatively dry area, sometimes spoken of as the **rain-shadow area.** The Western Ghats in India furnish us with a good example of this; the westward or windward slopes receive heavy rainfall and are covered with a very luxuriant vegetation, while the land in the rain-shadow area on the other side of the escarpment is rather dry grassland.

To the causes of rain already mentioned—convectional, cyclonic and orographical—may be added perhaps one more: nearness to the sea. The warm moisture-laden air from the sea may produce rain as it passes over the adjacent cold land in winter. It is not easy to isolate a case where the rainfall is of this type, called **coastal rain,** since cyclonic or orographic disturbances also exercise potent influences. But the eastern coasts of India and Australia illustrate fairly well this type of rainfall.

Distribution of rainfall. A rainfall map of the world shows that the distribution is very irregular, and yet certain features stand out with great clearness (Fig. 71). The hot equatorial low pressure belt receives heavy convectional rains which extend farther northward or southward with the swing of this belt. In July, the regions concerned are Central America, the Orinoco and north Amazon basins, in the western hemisphere, and central Africa from the sources of the Nile to

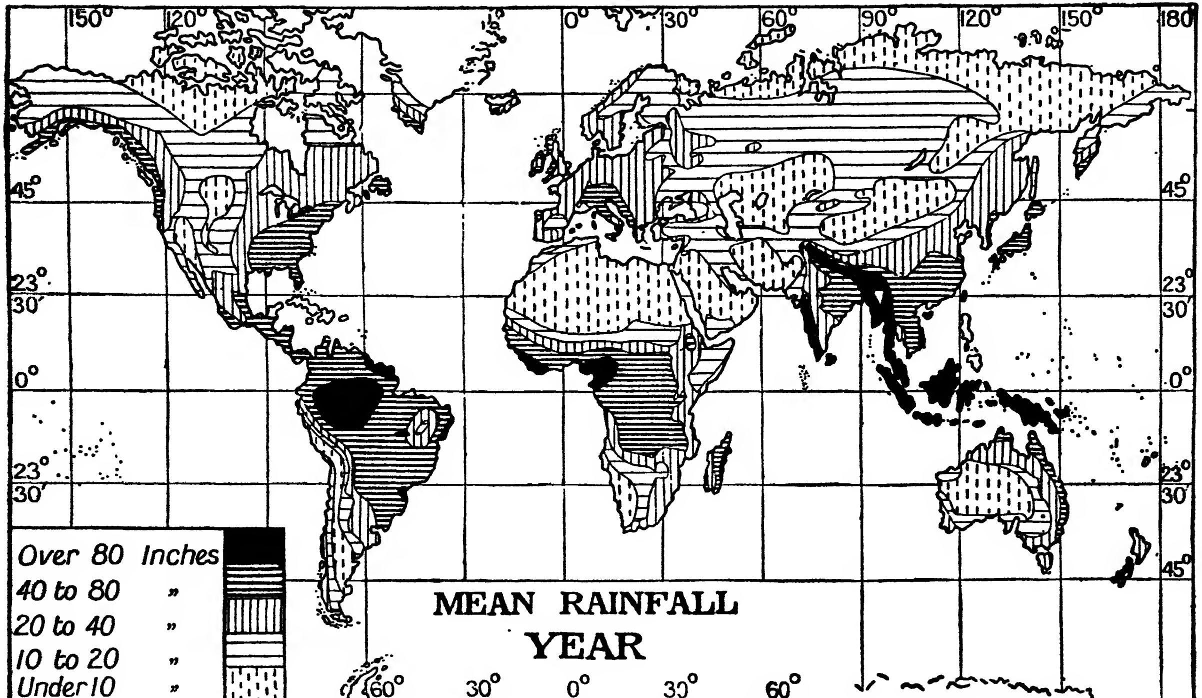

FIG. 71 Mean annual rainfall

the Sudan, and the East Indies, in the eastern. In January, however, equatorial rains are received by the south Amazon basin and the Brazilian Highlands in South America, the Congo and Zambesi basins in Africa and the southern East Indies in Asia. There are two dry belts, one to the north and one to the south of this equatorial belt ; here the pressure is high and trade winds blow out towards the equator. These winds, in their passage, enter zones of higher temperature, absorb more and more moisture and are dry water-absorbers. The northern dry belt, however, is not uniformly dry ; there is rainfall, which may be heavy rainfall in some parts, as in the monsoon regions of India, south-east Asia and the Gulf of Mexico. These convectional rains are reinforced in the Indian area by the obstruction offered by the Western Ghats, the Arakan Yoma of Burma and the Himalayas. The dryness of the southern belt is similarly relieved by relief rains on the Brazilian coasts and Madagascar. In January, southern and eastern Asia have winter monsoons and receive no rainfall, while northern and north-eastern Australia have heavy monsoon rains.

Farther polewards from these belts, there are the regions of relief and cyclonic rains due to the westerlies. These winds blow from lower to higher latitudes, enter regions of lower temperature, and thus yield rain. They are for this reason regarded as water-bringers. In July, these rains reach their southward limit in the latitudes of northern Spain in the northern hemisphere, while in the southern hemisphere Valparaiso, south-west Africa, south-west and southern Australia, Tasmania and New Zealand mark the northern limit. In January, these rains are confined to the coastal tracts, since the interiors experience high pressure and are therefore dry ; in the southern hemisphere, they are limited to Tasmania, New Zealand and the south of Chile.

The equatorial lands thus have rain all the year round ; but the swing of the temperature, pressure and rain belts gives rain to regions farther north and south, but only during a period of the year, the length of which depends upon remoteness from the equator. The north-east trade winds move northwards in the northern summer and yield no rain, except where the relief of the land causes some precipitation of moisture from them, or where the monsoon winds replace them, as in India. But these winds move southwards in the northern winter, and the regions between 30° and 40° N. now come under the influence of the westerlies which bring rain particularly on the western side of the continents. The south-east trade winds similarly give rise to rainless deserts in the southern hemisphere, and the migration of the westerly wind belt and its accompanying cyclones bring the western margins of South America, south-west Africa and south Australia under the influence of the rain-giving north-westerlies in winter. It may be noted that tropical regions outside the equatorial belt usually have rains in summer, and that winter rains are rare.

Broadly speaking, then, rainfall decreases as we pass from the equator towards the poles, and from the coasts towards the interior; in lower latitudes, the trade winds yield rain to the east coasts, while in middle latitudes the

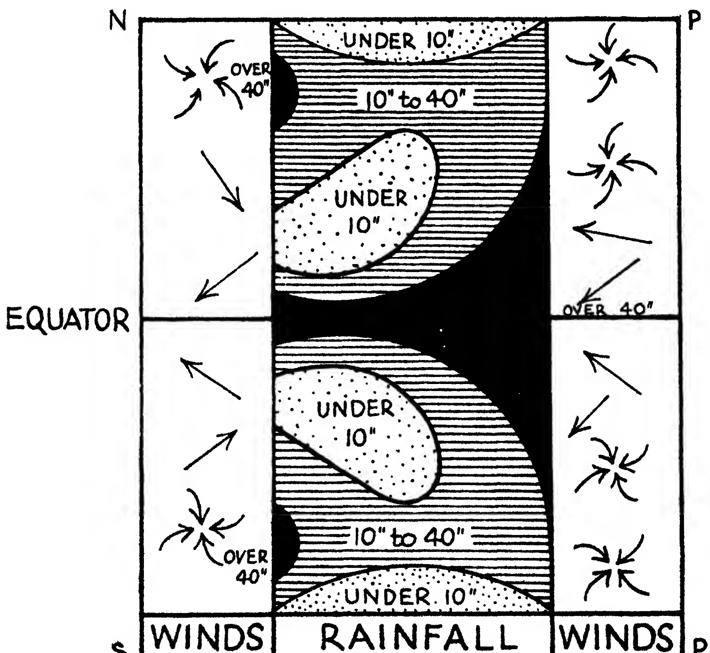

FIG. 72. Rainfall and winds

westerlies bring most rain to the west coasts ; coastal ranges receive rains on their windward slopes, but create rain-shadow areas on the leeward slopes. It will also be observed that there are regions of excessive drought on such leeward sides, in the interior of continental land masses, in the trade wind areas and in regions of extreme cold where the air naturally contains little moisture. The theoretical distribution of rainfall as shown in Fig. 72 clearly shows the contrasts between the rainfall conditions on the eastern and western margins and the influences on these of the trade winds and cyclones, and the differences between this ideal distribution and the actual conditions (Fig. 71) are accounted for by the disturbing factors of land and water alternations and the varying relief of the different land areas.

7. STUDIES IN CLIMATE

The various factors that influence the climate of a place have now been surveyed. We have seen how the temperature is affected by the latitude, altitude and distance from the sea, and how the amount and season of rainfall are determined usually by the direction of the prevailing winds and the relief of the land. The climatic statistics of climate given at the end of this section will supply enough material for observing and understanding the working of these various factors.

We thus see that places near the equator have a very small range of temperature, have temperatures of about 80° F. and have a very heavy rainfall of about 90 inches fairly well distributed throughout the year, but particularly heavy in summer and autumn. Singapore, Colombo, Sierra Leone and Georgetown well illustrate the equatorial type of climate. The different places have been arranged in order of their latitude, so that the working of this factor is very clearly seen in that, generally speaking, the winter temperature becomes lower and lower with increasing latitude. Thus Mangalore has 76°, Bombay 74°, Surat 70°, Calcutta 65°, Jubblepore 61°, Delhi 59°, Marseilles 44°, London 39° and Glasgow 38°. Special factors, such as the absence of an east to west mountain range like the Himalayas or the Alps, thus permitting the inflow of the cold Arctic winds, bring down the winter temperature to a lower figure than might ordinarily be expected, as is seen in the case of Odessa, Moscow, Chicago, and Montreal. The influence of a cold current is seen in the case of Halifax and Walvis Bay, while the influence of the sea can be observed from places in the same latitude, for example, Surat, Akola, Nagpur and Raipur. Places on the western sides of continental masses between latitudes 30° and 40° illustrate the Mediterranean type of climate with dry summers and wet winters, while tropical places, with heavy rainfall, on the eastern side, reveal monsoon conditions.

It may be gathered as a rough generalization from these statistics that the chief isothermal lines of 0° C., 10° C., 20° C. and 30° C., corresponding to 32°, 50°, 68° and 86° F., represent respectively the parallels of latitude of 66° 30′, 45°, 23° 30′ and 0°, and that the temperatures at intermediate latitudes can be found more or less roughly by proportion for winter, where the nearness or otherwise of the sea does not make a great difference. The range between the summer and winter temperatures is found to be roughly one-half the number of degrees of latitude, if the place is on the sea coast. Distance from the sea means a greater range than this; and for every 400 miles the range is greater by about 10° F. Altitude lowers the temperatures, it is well known, by 1° F. for every 300 feet.

These generalizations enable us to form an idea of the climate of a place if its situation is known. Thus Bombay has its winter temperature at about 74°, a range of 10° and therefore a summer temperature of 84° while Madras should have 77°, 7° and 84° respectively; but as Madras would not have on-shore winds in summer, the range might on that account be a little increased by, say, about 4°, so that the summer temperature there could be judged to be about 88°. The latitude of 21° would correspond to about 70° F. winter temperature and a range of 10·5°. Surat on the Gulf of Cambay would therefore have about 6° greater range and a summer temperature of 86·5°, while Akola distant about 300 miles from the sea would have a range of 7·5° more and the temperature would be lower by about 3° on account of altitude, so that its winter temperature would be about 67° and the summer temperature about 91°. Nagpur and Raipur would have much the same temperatures. Consider Mexico City. It should have the same temperatures as Bombay; but the altitude lowers the temperatures by about 25° and the distance from the sea—about 200 miles—raises the range by about 5°; further, the Gulf Stream warms the land by a few degrees in winter; the winter and summer temperatures are therefore not 74° and 84° as at Bombay, but 74°-25°, that is, 49°,+3° =52°, and 49°+9·5°+5°=63·5°, respectively.

At London, the winter temperature should be about 44°, but the cold easterly winds lower it and it may therefore be taken to be about 39°. Adding 25·5° for the range, the summer temperature should be about 64·5°. Warsaw in about the same latitude is, however, chilled in winter by the absence of a transverse mountain system and has about 25° as its winter temperature. Adding 26°, the range due to latitude, and about 12° for its distance from the North Sea, the summer temperature should be about 25°+26°+12°, that is, 63°.

In this way, it is possible to determine approximately the mean temperatures in the coldest and hottest months at any place if its situation is known. The reverse circulation is no less interesting and it should be possible to determine the locality of a place if its climatic statistics are known. Thus, from the following table, we see that the place A is in the

	Places				
	A	B	C	D	E
Altitude in feet	224	94	448	49	4,462
Mean temperature in January, °F.	79·0	63·0	77·0	56·5	74
Mean temperature in July, °F.	70·1	91·0	86·0	72·5	59
Rainfall in December to February in inches	14·6	0·3	3·3	15·0	15
Rainfall in March to May in inches	13·8	0·4	5·4	10·9	5
Rainfall in June to August in inches	5·4	6·4	8·1	2·2	1
Rainfall in September to November in inches	9·7	0·9	18·3	4·7	7
Total Rainfall in inches	43·5	8·0	35·1	32·8	28

southern hemisphere, as January and not July is the hottest month. The range being about 9°, the latitude can be expected to be about 18° S. The fairly heavy rainfall for the year, and particularly in summer and autumn, suggests the eastern coast of Africa or of South America and points to Rio de Janeiro or Beira. Place B is in the northern hemisphere; the January temperature suggests a latitude of about 28° N. The rainfall suggests a very dry region, while the range suggests an inland place not so far removed from the sea, the summer temperature being influenced by the dry conditions in summer. The place is probably in Sind, since other possible regions have not so little rainfall. Place C is obviously near the sea at about 6° N. latitude; the rainfall, however, is too low for this latitude and suggests that the place is some distance inland. Possible localities near the Guinea coast must be rejected on account of the heavier rainfall there; those on the eastern coast of Africa on account of their scantier rainfall. Similarly South America can be ruled out. The only locality that suggests itself therefore to satisfy the given requirements is southern India. Place D is in the northern hemisphere at about 36° latitude; the winter rainfall suggests the Mediterranean type of climate; California being excluded on the ground of higher latitude, there remain southern Europe and northern Africa; and of the large towns, the probabilities are in favour of Gibraltar, Tangier and Algiers. Place E is in the southern hemisphere; the latitude appears to be about 30° from the range; but the lowering of the temperature through rise in altitude suggests a lower latitude, say, about 25°. The place is too high to be a coastal town and the range suggests that it would be about 200 miles from the coast. The only possible locality is therefore South Africa towards the eastern coast, probably in Transvaal.

In this way, interesting speculations about climate can be made, leading to a better and clearer understanding of the various factors that govern it.

STATISTICS OF CLIMATE

(PLACES ARE ARRANGED ACCORDING TO LATITUDE)

A. NORTHERN HEMISPHERE

Serial Number	Place	Latitude °N.	Altitude in feet	Temperature in °F.		Rainfall in inches				
				Hottest month	Coldest month	December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
1	Singapore	1	—	83	79	31	7	24	40	102
2	Lado	5	1,526	82	77	—	10	20	8	38
3	Bogota	5	8,727	56·3	5·7	13	20·9	9·2	21·2	64·3
4	Accra	6	—	84	78	11	36	44	40	131
5	Lagos	6	25	79	77	5	22	26	17	70
6	Georgetown	6	10	78·9	78·6	23	23·2	28·4	6·8	81·4
7	Colombo	7	40	83	79	11·1	27·5	18·2	30·5	87·3
8	Nuwara Eliya	7	6,240	61	57	16	16·8	37·5	28·6	98·9
9	Kandy	7	1,696	79	74	10	16·7	23·1	28·7	84·5
10	Trincomalee	8	175	85	78	21·8	5·1	8·3	26·6	61·8
11	Sierra Leone	8	224	82	80	2	20	98	52	172
12	Colon	9	164	79·2	79	15·6	15·6	43·1	49·9	124·2
13	Cochin	10	11	84	79	3·5	19·2	65·8	26·6	115·1
14	Madura	10	448	86	77	3·3	5·4	8·0	18·3	35
15	Port Blair (Andaman Is.)	11	61	83	79	7·5	18·7	49·6	40·9	116·7
16	Trichinopoly	11	275	88	76	4·6	6·3	7·9	18·3	37·1
17	Coimbatore	11	1,348	83	74	1·5	5	4·3	10·3	21·1
18	Ootacamand	11	7,252	59	48	2·3	11·3	15·8	16·4	45·8
19	Mergui	12	96	81	76	2·4	23·9	89·5	43·3	159·1
20	Mercara	12	3,695	72	64	0·9	9·4	93·6	22·9	126·8
21	Gondar	12	7,422	67	62	0	3	32	10	45
22	Madras	13	22	88	76	6·4	3·2	10·3	29·2	49·1
23	Bangalore	13	2,981	80	67	1	6·9	13·1	14·6	35·6
24	Mangalore	13	52	83	76	0·8	10·2	98·8	21·2	131
25	Aden	13	—	89	77	0	1	0	0	1
26	Bellary	15	1,455	89	73	0·4	3·2	5·4	86	17·6
27	Massawa	15	31	94	77	5	1	1	1	8
28	Moulmein	16	94	83	75	0·2	22·8	125·3	40·2	188·5
29	Rangoon	16	41	84	75	0·4	12·8	58·3	27·5	99
30	Masulipatam	16	10	88	74	1·1	2·1	16	19·3	38·5
31	Belgaum	16	2,550	81	71	0·4	5·3	33·5	9·6	48·8
32	Khartoum	16	1,275	92	67	—	—	—	—	—
33	Sholapur	17	1,590	89	70	0·5	2·2	14·9	11·9	29·5
34	Secunderabad	17	1,787	89	69	0·8	2·8	15·4	9·3	28·3
35	Poona	18	1,849	86	72	0·4	2·4	16·3	9·2	28·3
36	Kingston	18	10	81·6	76·5	4·1	8·1	11·7	14·5	38·4

Serial Number	Place	Latitude °N.	Altitude in feet	Temperature in °F. Hottest month	Coldest month	Rainfall in inches December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
37	Bombay	19	37	85	74	0·2	0·5	60·6	13·1	74·4
38	Ahmednagar	19	—	—	—	—	—	—	—	—
39	Toungoo	19	181	85	70	0·4	8·1	49	20·6	78·1
40	Thyet Myo	19	134	87	68	—	6·1	24 4	15	45·5
41	Vera Cruz	19	26	82·9	70 4	3	5	36·7	24·2	68·9
42	Mexico	19	7,490	62·4	53 8	0·5	3·2	13·2	6·3	23·2
43	Akyab	20	20	84	69	0·9	14·3	141·2	39·3	195·7
44	Cuttack	20	80	89	70	1·5	5·8	34·5	16·6	58·4
45	Malegaon	20	1,430	88	66	1	1·4	13·5	9·2	24·7
46	Surat	21	36	86	70	0·1	0·2	33	8·8	42·1
47	Akola	21	930	93	66	1·4	0·7	19·7	8·4	30·2
48	Nagpur	21	1,025	93	67	1·5	1·9	31	10·5	44·9
49	Haipur	21	960	92	66	0·9	2·1	37·3	10·7	51
50	Hong-Kong	22	—	84	60	4	23	44	14	85
51	Mandalay	22	250	91	71	0·2	5·4	10·4	11·5	27·5
52	Chittagong	22	87	82	67	2·2	15·7	66·5	21·4	105·8
53	Calcutta	22	21	85	65	1·7	9·2	38·7	16	65·6
54	Seoni	22	2,030	87	63	2·3	2	36·1	10·5	50·9
55	Pachmarhi	22	3,528	83	56	1·5	1·3	57·8	17·4	78
56	Indore	22	1,823	87	62	0·9	0·7	25	9·5	36·1
57	Jessore	23	33	84	65	1·6	14·2	36·6	15·6	68
58	Burdwan	23	99	86	66	1·3	8·6	34·5	13·3	57·7
59	Jubblepore	23	1,341	90	61	1·4	1·2	40·9	10·1	53·6
60	Havana	23	62	83·7	72·6	7·2	8·9	15·6	15·2	46·9
61	Dacca	24	22	83	66	1·6	17·5	38·5	16·1	73·7
62	Berhampore	24	66	85	65	1·5	7·7	30·8	15·4	55·4
63	Hazaribagh	24	2,007	85	61	1·4	2·7	33·6	11·7	49·4
64	Saugor	24	1,769	89	63	1·8	1	34·3	9	46·1
65	Neemuch	24	1,639	88	62	0·5	0·7	25·5	6·5	33·2
66	Deesa	24	465	92	67	0·4	0·4	20·5	4·2	25·5
67	Mt. Abu	24	3,945	79	58	0·8	1·1	49·8	11·4	63·1
68	Shillong	25	4,792	69	51	1·6	15·7	45·4	22·6	85·3
69	Silchar	25	104	82	64	3·9	36·6	57·9	21·6	120
70	Gaya	25	375	92	64	1·4	1·9	28	9·7	41
71	Patna	25	183	89	61	1·4	2·2	28·2	11	42·8
72	Benares	25	267	91	61	1·3	1·1	28·5	8·7	39·6
73	Allahabad	25	307	92	61	1·4	0·9	26·1	9·2	37·6
74	Jhansi	25	855	95	63	0·9	0·8	28·1	6	35·8
75	Hyderabad (Sind)	25	94	91	63	0·3	0·4	6·4	0·9	8
76	Karachi	25	49	81	65	1·1	0·5	5·1	1·1	7·8
77	Dhubri	26	115	82	63	1	22·6	53·2	16·7	93·5
78	Purnea	26	125	84	62	1·1	5	40	18·5	64·6
79	Darbhanga	26	166	85	62	1·1	3·2	30·3	12·8	47·4
80	Lucknow	26	369	92	61	1·6	1·3	26·2	8·5	37·6

Serial Number	Place	Latitude °N.	Altitude in feet	Temperature in °F. Hottest month	Coldest month	Rainfall in inches December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
81	Ajmer	26	1,611	89	58	0·8	1·2	16·7	3·8	22·5
82	Darjeeling	27	7,421	61	39	2·5	14·7	85·4	24·5	127·1
83	Sibsagar	27	333	85	59	3·9	25·3	45·7	18·2	93·1
84	Agra	27	555	95	60	1·0	1·1	19·4	4·7	26·2
85	Jaipur	27	1,431	91	61	0·9	1·1	18·4	3·4	23·8
86	Bikaner	28	744	95	61	0·5	1·9	8·4	1·7	12·5
87	Jacobabad	28	186	96	57	0·5	0·6	2·9	0·4	4·4
88	Teneriffe (Canary Is.)	28	1,790	70	56	7	2	0	3	12
89	Meerut	29	737	92	57	2	1·9	20	4·6	28·5
90	Delhi	29	718	93	59	1·9	1·8	18·8	5·1	27·6
91	Sirsa	29	662	93	56	1·3	1·5	9·6	2·3	14·7
92	Ranikhet (U.P.)	30	6,069	71	46	4·9	6·5	30·3	7·4	49·1
93	Dehra Dun	30	2,232	84	55	4·7	3·7	58·4	10·2	77
94	Roorkee	30	887	90	56	3·8	2·6	29·9	5·9	42·2
95	Multan	30	420	94	54	1	1·3	3·9	1	7·2
96	Quetta	30	5,501	77	40	3·9	4·2	1·5	0·3	9·9
97	Cairo	30	96	85	54·2	0·7	0·4	0	0	1·1
98	New Orleans	30	52	82·5	54·1	14·1	15·3	19·4	12·2	61·2
99	Chakrata (U.P.)	31	7,052	67	42	6·1	7·8	40·4	6·6	60·8
100	Simla	31	7,046	67	41	6·6	10·5	45·3	7·7	70·1
101	Ludhiana	31	812	91	52	3·4	3·7	18·5	5·6	31·2
102	Lahore	31	732	93	54	2·3	2·6	13·8	3·2	21·9
103	Sialkot	32	830	91	52	4	4·7	23·9	4·2	36·8
104	Dera Ismail Khan	32	573	93	52	1·4	2·1	4	0·8	8·3
105	Murree	33	6,344	71	39	7·4	11·8	27·4	10	56·6
106	Leh	33	11,503	62	18	0·5	0·4	1·1	0·7	2·7
107	Rawalpindi	33	1,652	89	49	5·5	5·8	16·4	4·7	32·4
108	Tripoli	33	98	79	58	8	2	0	4	14
109	San Diego	33	67	67·7	53·2	5·6	2·4	0·2	1·4	9·6
110	Peshawar	34	1,110	89	50	3·4	4·5	4	1·6	13·5
111	Biskra (Africa)	35	409	90	52	2	3	0	2	7
112	Tunis	36	46	80·8	56·3	6·4	5·9	2·9	4·3	19·5
113	Algiers	36	72	76·6	54	12·5	8·5	2	4·2	27·2
114	Gibraltar	36	49	72·5	56·5	15	10·9	2·2	4·7	32·8
115	Smyrna	38	25	79·9	47·4	13	8·2	1·9	2·8	25·9
116	Athens	38	361	79	51·8	8·9	4·1	1·9	3·4	18·3
117	Palermo	38	327	76·5	52·2	11	7·4	1·3	9·8	29·5
118	San Francisco	38	60	58·5	50·4	13·9	5·8	0	3·9	23·6
119	Lisbon	39	335	70	50·8	11·5	10	2·8	4·6	28·9

Serial Number	Place	Latitude °N.	Altitude in feet	Temperature in °F Hottest month	Coldest month	Rainfall in inches December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
120	St. Louis	39	571	78·4	31·1	7·8	11·9	12·5	9·1	41·3
121	Madrid	40	2,149	77·4	40·1	4·9	4·8	3·4	3·6	17·7
122	Denver	40	5,294	73·2	27·8	1·6	5·8	4·4	2·5	14·3
123	Constantinople (Istanbul)	41	230	73·9	41·7	11·3	6·3	4	7	28·6
124	Barcelona	41	138	75·7	47·7	4·4	5·4	3·5	8·2	21·5
125	New York	41	164	73·6	30·3	10·5	11·2	12·7	10·8	45·2
126	Omaha	41	1,113	76·2	21·1	2·4	9·2	13·4	6·8	31·8
127	Salt Lake City	41	4,348	76·3	28·7	5·3	6·2	3·3	4·2	19
128	Rome	42	163	76·6	44·8	10·8	7·2	4·3	8·1	30·4
129	Boston	42	142	71·3	27·4	11·4	11·8	11·2	11·6	46
130	Chicago	42	661	72·9	25·5	6·6	9·2	10·1	8·4	43·3
131	Sofia	43	1,764	73	28·8	4·3	4·4	7·7	5·9	22·3
132	Marseilles	43	246	72	44·2	7·2	5·3	3·2	6·7	22·6
133	Buffalo	43	696	70	24·4	9·2	8·7	10·3	10·8	39
134	Florence	44	249	76·3	40·6	11·6	8·3	6·2	10·7	36·8
135	Genoa	44	177	75·4	45·5	17·1	13·3	7·2	14·4	52
136	Bologna	44	279	75·7	33·8	8·1	6·8	6·3	8·4	29·6
137	Halifax	44	122	63	22·1	16·5	13·5	11·1	14·3	55·4
138	Venice	45	69	76·5	37·4	6·5	5·8	8·6	9·1	30
139	Montreal	45	187	69·8	13·4	10·4	9·1	9·5	10·6	39·6
140	St. Paul	45	801	71·8	12	3	7·6	11·4	6·6	28·6
141	Portland (Oregon)	45	67	67·2	39·5	20·8	11·5	2·9	11·6	46·8
142	Astrakhan	46	66	78·1	20·6	1·4	1·6	1·7	1·4	6·1
143	Odessa	46	214	73·3	26·4	2·9	3·6	5·5	4	16
144	Trieste	46	85	76·3	40·5	9·2	8·2	10·8	14·4	42·6
145	Debreczen	47	453	71	27·4	5·7	4·6	9	5·7	25
146	Budapest	47	502	71·1	29·4	5·8	5	7·2	6·3	24·3
147	Berne	47	1,880	69·8	29·4	7	7·3	12·1	11·6	38
148	St. John's	47	150	59·7	23·8	13·5	13	11·7	14·6	52·8
149	Quebec	47	313	66·5	9·1	9·8	8·4	10·9	10	39·1
150	Brest	48	210	64·1	43·5	10·5	7·4	6·1	8·9	32·9
151	Vienna	48	69	76·5	37·4	6·5	5·8	8·6	9·1	30
152	Munich	48	1,734	63·7	27·6	4·8	8·6	14·5	7·6	35·5
153	Paris	49	256	66	37·2	4·1	4·9	6	5·9	21
154	Vancouver	49	—	65	34	24	9	6	15	54
155	Breslau	51	483	65·8	29·4	3·5	5·1	8·6	5·9	23·1
156	Brussels	51	187	65·7	36·9	7·5	5·6	8	8·8	29·9
157	London	51	159	63·6	38·8	5·3	5·2	6·9	7·4	24·8
158	Warsaw	52	392	66·7	26	3·8	4·7	8·9	5·2	22·6
159	Amsterdam	52	30	63·7	36·4	6·7	4·5	6·6	8·9	26·7
160	Winnipeg	52	740	66·1	−5·2	2·4	6·6	9·6	4·6	23·2

Serial Number	Place	Latitude °N.	Altitude in feet	Temperature in °F. Hottest month	Temperature in °F. Coldest month	Rainfall in inches December to February	Rainfall in inches March to May	Rainfall in inches June to August	Rainfall in inches September to November	Rainfall in inches Total
1	2	3	4	5	6	7	8	9	10	11
161	Stettin	53	128	65·7	31	4·2	3·6	7	6·1	20·9
162	Berlin	53	157	66·7	32·8	4·9	5	7·4	5·6	22·9
163	Hamburg	53	64	63·4	33·1	6·6	5·4	8·8	8·3	29·1
164	Dublin	53	—	60	42	6	6	7	8	27
165	Edmonton	54	2,388	61·4	10·6	2·4	3·8	9·1	3·2	18·5
166	Moscow	56	509	66·2	13·1	2·8	4·6	7·6	5·2	20·2
167	Copenhagen	56	43	62·1	32·1	4·7	3·6	6·2	7·3	21·8
168	Glasgow	56	184	58·1	38	11·3	6·9	10·1	11·4	39·7
169	Stockholm	59	146	62	27·3	3·3	2·4	5·4	6·3	17·4
170	Leningrad	60	19	63·7	17·2	2·9	3·4	7·1	5·1	18·5
171	Oslo	60	135	62·8	24·3	4·5	3·1	7·3	8·7	23·6
172	Bergen	60	49	58·5	34	22·1	14·3	15·1	25·1	76·6
173	Archangel	65	33	60·8	7·7	2·7	2·6	5·7	4·7	15·7
174	Tromsö	70	50	51·8	26·4	11·9	10·8	6·7	11·3	40·7
175	Upernivik	73	39	40·5	−5·8	1·3	2	2·2	2·7	8·2

B SOUTHERN HEMISPHERE

Serial Number	Place	Latitude °S.	Altitude in feet	Temperature in °F. Hottest month	Temperature in °F. Coldest month	Rainfall in inches December to February	Rainfall in inches March to May	Rainfall in inches June to August	Rainfall in inches September to November	Rainfall in inches Total
1	2	3	4	5	6	7	8	9	10	11
1	Quito	0	9,350	56·5	59·5	10·6	17	4·5	10·4	42·5
2	Para	2	0	81·5	80·1	23·2	34·1	12	6·6	75·9
3	Manáos	3	121	78·6	78·4	28·8	32·7	11·2	13·1	85·8
4	Vivi	5	374	78	71	14	15	0	12	41
5	Zanzibar	6	23	82	77	14	33	6	12	65
6	Loanda	8	194	77	66	3	8	0	2	13
7	Carácas	10	3,043	72	68·5	1·7	3·5	13·2	13·2	31·6

Serial Number	Place	Latitude °S.	Altitude in feet	Temperature in °F. Hottest month	Coldest month	Rainfall in inches December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
8	Cape York	11	70	81	77	50	29	2	2	83
9	Port Darwin	12	70	85	78	40	16	0	7	63
10	Bahia	12	330	82·8	74·8	12·6	35·2	24·9	17·4	90·1
11	Lima	12	499	74·3	57·6	0	0	1 5	0·8	2·3
12	Apia (Samoa)	13	0	79	75	55	29	15	28	127
13	Tete	16	250	85	73	19	10	0	5	34
14	Tahiti (Society Is.)	18	0	78	75	19	13	5	9	46
15	Bulawayo	20	—	93	73	0	6	12	4	22
16	Mackay	21	200	81	62	37	28	6	6	77
17	Walvis Bay	22	10	65	58	0	0	0	0	0
18	Rockhampton	23	0	82	57	22	10	5	6	43
19	Rio de Janeiro	23	224	79	70·1	14·6	13·8	5·4	9·7	43·5
20	Alice Springs	24	2,100	85	53	5	2	1	1	9
21	Pretoria	25	4,462	74	59	15	5	1	7	28
22	Lourenço Marques	26	16	80	66	16	5	1	4	26
23	Asuncion	26	322	85·6	64·3	18·6	15·7	8·4	15·6	58·3
24	Brisbane	27	130	78	59	20	16	9	9	54
25	Geraldton	28	5	73	57	1	4	11	2	18
26	Bloemfontein	29	4,550	73	47	11	6	1	5	23
27	Pietermaritzburg	29	2,093	72	56	15	8	2	10	35
28	Bourke	30	456	84	51	8	4	2	4	18
29	Durban	30	—	75	63	3	16	14	10	43
30	Eucla	31	7	70	54	1	4	3	2	10
31	Graaf Reinet	32	2,500	74	52	16	5	1	4	26
32	Perth	32	2,641	73·4	46·4	2·8	2·5	0·6	1·6	7·5
33	Bathurst (Australia)	33	2,200	73	43	7	6	6	6	25
34	Capetown	33	37	70	55	2	7	11	5	25
35	Santiago	33	1,703	68·7	47·8	0·3	3	7·4	2·3	13
36	Wentworth	34	144	79	50	2	4	3	4	13
37	Sydney	34	155	71	52	12	16	13	9	50
38	Port Elizabeth	34	181	71	57	4	6	6	7	23
39	Albany	35	88	65	56	3	9	15	8	35
40	Monte Video	35	39	73	51·8	9·4	11·9	9·9	12·8	44
41	Buenos Aires	35	12	75·6	50	9·2	10	6·4	9	34·6
42	Auckland	36	258	67	52	9	10	14	10	43
43	Adelaide	36	140	75	51	2	6	8	5	21
44	Melbourne	37	91	66	47	6	6	6	8	26
45	Valdivia	40	43	59	43·7	11·2	31·7	55·1	17·8	115·8

Serial Number	Place	Latitude °S.	Altitude in feet	Temperature in °F. Hottest month	Coldest month	Rainfall in inches December to February	March to May	June to August	September to November	Total
1	2	3	4	5	6	7	8	9	10	11
46	Wellington	41	140	62	47	10	11	17	13	51
47	Hokitika	42	12	60	45	30	29	31	29	119
48	Chumbut (Patagonia)	43	98	70	42·4	1·8	2·4	2·6	2·1	8·9
49	Christchurch	43	21	62	42	5	6	7	5	23
50	Hobart	43	37	61	47	65	5	6	7	23
51	Dunedin	45	500	58	42	9	9	9	8	35
52	Punta Arenas	52	33	51·5	34·6	4·6	5·7	7·0	4·2	21·5

Chapter IV

VEGETATION AND ANIMALS

1. INFLUENCE OF CLIMATE

Though plants may differ considerably from one another, they fall easily into groups, the plants in each group having the same general aspect and character, and being influenced by the same physical environment; and in order to understand plant geography, it is more important to study the general character of vegetation in different regions than the particular species of plants growing there. Whether vegetation is luxuriant or scanty, whether it consists of perennial trees and shrubs or annual grasses are matters of primary importance; and though one cannot correlate quantitatively the different types of vegetation with latitude, isotherms or isohyets (lines of equal rainfall), it is obvious that physical features exercise a powerful control on these types, which have their distinctive requirements of soil and climate.

Soils. Soils differ greatly. They may be fine, clayey, compact and firm, heavy and wet or they may be coarse, **sandy,** porous and loose, light and dry, or they may be intermediate, loamy. Indeed, we can have further intermediate types, such as **sandy loams** or **clayey loams.** Such physical differences in soils affect considerably their suitability for different types of vegetation, and, indeed, for different plants. Differences in chemical composition of soils also play no less important a part. Plants require many substances in different proportions; but among the most important constituents of plant food are nitrates, phosphates and potassic salts, and the fertility of soils depends, apart from their physical composition, on their richness in these three essentials. **Alluvial soils,** and particularly **deltaic soils** in river basins and coastal regions, are both physically and chemically rich soils favouring a luxuriant growth of vegetation. **Humus** or **vegetable mould** also gives a rich soil on account of the presence of decayed vegetable matter, while a **basaltic soil,** the result of disintegrated lava erupted long ages ago, is rich in mineral constituents and therefore very productive. Thus the well-known **Deccan trap,** and particularly that part of it known as the **black cotton soil,** is very retentive of moisture, and is very useful for the growth of cotton in central and western India. Sometimes the presence of salt and lime also becomes a factor of no small significance for certain plants.

Climatic requirements. While in this way the soil exercises an important physical control on vegetation, its deficiencies admit of correction by manuring and otherwise. Further, soils differ so greatly within a region that we can see that soil control is not primarily effective, when we consider broadly the distribution of vegetation on the surface of the Earth. Climate, however, stands out as the chief regulator of the type of vegetation in the different regions of the world, and it is to the influence of **sunlight, heat** and **moisture** that the differences in the general aspect and character of vegetation in different parts can be traced.

Sunlight is necessary for plant growth. It is during daylight that plants are able to assimilate their food and grow, while darkness arrests their growth. In higher latitudes, therefore, where days are long in summer, plants grow and mature with extraordinary rapidity. Intense light promotes very bright colours, and the sunny skies of India and other tropical regions produce a bewildering variety of brightly-coloured flowers, while the clouded skies of the temperate areas yield pale and greyish hues. In the mountain regions, the absorption of light by the rarefied air is slight, and this explains the bright colours in the flowers of the lovely valley of Kashmir and on hill stations like Mahabaleshwar.

The effects of **heat** and **moisture,** that is, of temperature and rainfall, can hardly be recognized as separate. Rainfall is, in a certain measure, associated with the wind system, which is regulated by differences in atmospheric pressure, which in its turn depends very much upon differences in temperature.

Temperature. For particular plants there are temperature limitations. The mango tree will not grow in temperate regions ; oats will not grow in equatorial areas ; rice is tropical and sub-tropical, while wheat is sub-tropical and temperate. Similarly, sugar-cane and sugar-beet are respectively tropical and temperate. The temperature factor thus seems almost absolute, and man can control it only by altering the season for growth. For example, wheat in higher latitudes may grow in spring, but in India it has to be a winter crop. Late or early sowing can make a little adjustment possible, but after all, different plants have their own temperature requirements. While particular temperatures may be unsuitable for particular plants, they are not so for plant life in general ; for vegetation is found in thermal springs, and near Verkhoyansk, the cold pole, there is actually forest growth.

Resting period. It is only when the freezing-point is reached that plants are unable to utilize moisture, and their growth is then arrested. Temperature differences also give rise to resting periods for plants. Near the polar regions there are but a few weeks of warm weather, and plant growth has therefore to be completed within that short time, the remaining months of the year being a long resting period. Prolonged low temperature is a feature of temperate regions and gives to vegetation a resting period of from four to six months ; the trees shed their leaves and the surface parts of small plants wither and die. In the summer-rainfall regions of the tropical zone also, a sort of resting period is experienced during the latter part of the dry season. Where winters are severe and summers dry, plants burst out suddenly in spring and wither at the close of the early summer.

Rainfall. The amount of rainfall during the growing season is a matter of considerable importance to plant life, and this has to be considered in connexion with the factor of evaporation. Plants absorb moisture which holds the constituents of plant food in solution, and they give off water through pores in the under surface of their leaves. Plant life therefore depends upon a proper adjustment between absorption and transpiration. Heavy rainfall, well distributed throughout the year or a part of it, and even light rains if well distributed, promote the growth of forests and woodlands, while light rains, not so well distributed, lead to grasslands.

Plants have various devices by which they adjust themselves to some extent to the supply of moisture. When the supply is great, there is an arrangement for rapid transpiration by large leaf-surface and by the trees bearing leaves all the year round. Where there is a definite dry season, means to check transpiration are found. Some trees shed their leaves; others have leaves which are small or even reduced to thorns or spines which clearly afford little transpiratory surface; in others the leaves are rolled back to retard transpiration; whilst still others have leaves with a thick skin. In dry regions, underground water becomes an important source of moisture, and plants develop long roots to enable them to reach it. In deserts, rainfall is a rare phenomenon; but when it does come, the subsoil is for the time being moist, and the few shrubs and plants which spring up there have developed devices for conserving the scanty water-supply and for checking transpiration.

Winds. Winds also sometimes exercise a considerable influence on vegetation. Where they blow with great force they promote rapid transpiration, which may check or prevent the growth of trees, and wither up the leaves. Warm winds melt the snows in regions of severe winter and supply the moisture necessary for the germination and early growth of plants.

2. VEGETATION REGIONS

Main types. Well distributed rainfall promotes the growth of **forests**; and the absence of rain will result in the absence of vegetation giving regions of **deserts.** In nature, however, there is no clear-cut demarcation, no sharp division between one region and another. A region of heavy rainfall thus merges gradually into a region of no rainfall, and a forest region passes into a desert region through the intermediate stage of a **grassland.** Large trees mark a forest, while in grasslands we have grasses, and annuals or plants that germinate and die and complete their life cycle in the course of a year. Thus, we have three principal types of vegetation—the **forest, grassland** and **desert.** Forest passes into grassland through an intermediate type where a few trees mingle with a few annual grasses, as in a park, so that this intermediate region is known as a **parkland** in the tropical regions and as a **woodland** in temperate latitudes. Similarly, an intermediate type can be recognized between the grassland and the desert; here vegetation is very dwarfed and scanty. This type is known as **scrubland.** The generally accepted classification of natural vegetation, therefore, gives us five main types, **forest, parkland, grassland, scrubland** and **desert.**

Natural vegetation regions. On the surface of the Earth, we have two belts where the rainfall is well distributed throughout the year. The equatorial region has heavy convectional rains all the year round. The westerlies bring rain to the temperate regions roughly beyond latitude 40°, and this rainfall is also fairly evenly distributed, though not generally so heavy as in the equatorial belt. In these two regions, we have forests which may be distinguished as the equatorial and temperate forests. The trade winds, being ' water-drinkers ' take up further moisture rather than part with any, in their passage towards the equator, and unless forced to give rain by the relief of the land, they lead to the formation of desert regions. Polar regions are similarly deserts, since the severe cold deprives vegetation of the supply of moisture, which is in the form of snow or ice, forms not capable of being absorbed by plants. Starting then with the four main regions, we have the **equatorial forests,** the **tropical desert,** the **temperate forest** and the **polar desert.** Interpolating the transitional belts of vegetation, there are, as we move from the equator to the poles, the **equatorial forest, parkland, tropical grassland, scrubland, tropical desert, scrubland, temperate grassland, woodland, temperate forests, polar grassland** (not commonly so called) and **ice-desert,** anything like a woodland or scrubland being not worth while distinguishing in the cold regions. The succession of the natural vegetation regions from the equatorial forest to the tropical desert is perhaps nowhere better seen than in Africa, where the rainfall gradually decreases in amount and alters in distribution.

On the eastern margins, however, this succession is modified by the fact that the monsoons develop a characteristic forest vegetation, which reaches and blends with the temperate forest, while in the west, the swing of the equatorial heat, pressure and wind belts brings winter rainfall from the westerlies to the countries between latitude 30° and 40°. This rain,

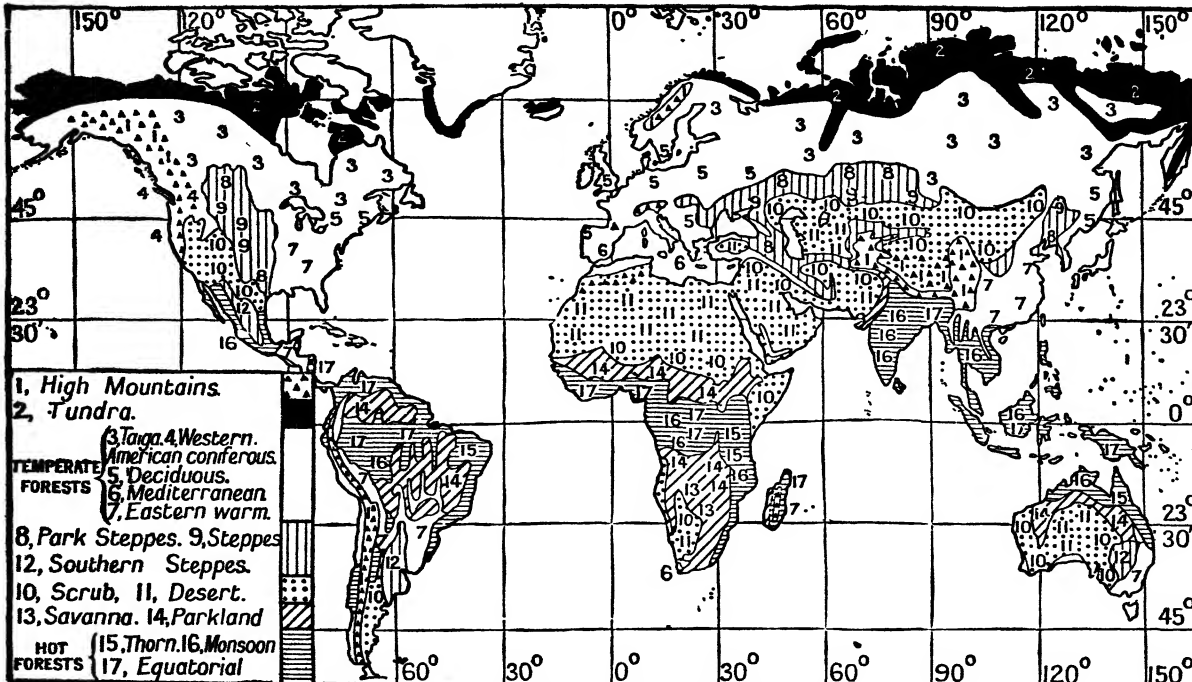

Fig. 73. Distribution and natural vegetation

falling in a season of low evaporation, promotes the growth of forests of a sparse and stunted type (Fig. 73).

Equatorial forests. The great heat and heavy rainfall in equatorial regions lead to a luxuriant growth of vegetation, and the characteristic form is the forest. There is a bewildering variety of plant life, giant trees, some two hundred feet high with festoons of writhing creepers, shrubs, and undergrowth, all making such a great mass of vegetation in the dense and almost impenetrable forest that there is a veritable struggle for the plants to get sunlight. We find leaves, flower and fruit all the year round, and the forest is evergreen, though some trees are deciduous, that is, they shed their leaves. The vegetation forms a carpet over the soil with no bare patches at all. The typical tree of the equatorial forest is the **palm,** of which there are many varieties. **Hardwoods** and dye-woods like mahogany, ebony, teak and rosewood abound, and **rubber-yielding** trees and bamboos, are very common. The Congo basin and the Guinea coast in Africa have such equatorial forests. The Amazon basin in South America has even larger and denser forests known as the **selvas** ; in fact the area is one vast dense forest, little fitted to be the home of man. Equatorial forests are also found in the East Indies, where the palms predominate, though rubber and other plantations are now being developed.

Monsoon forests. The heavy rains in the monsoon region give rise to dense forests very similar to equatorial forests, though the rains are seasonal. In India, the windward slopes of the Western Ghats and the Himalayas, where the monsoon rains are very heavy, are covered over with extensive forests of this type. Similar forests also cover vast areas on the mountains and plains of Burma and the Malay Peninsula, as well as those parts of the northern coasts of Australia which are subject to the monsoons.

Tropical grasslands. On the borders of the equatorial region, the rainfall is plentiful in summer, but there is a fairly long dry season, which does not favour the growth of dense forests, since these require an unfailing supply of water in the subsoil. In such regions, grasses grow well in the short wet period but die down in the dry season. Few and scattered trees may grow here and there, particularly in wet valleys, but the prevailing type of vegetation is the grasses, which may cover the whole countryside. Man clears this growth and cultivates the land for particular crops. If this were not done, the greater part of India would be a tropical grassland, except where the rainfall is too heavy (as on the west coast), or where it is too scanty or almost absent (as in the desert regions of Sind and Thar). In Africa, where they are called **savannas,** these grasslands form an extensive area on either side of the equatorial region. In Australia the savannas are south of the monsoon forests ; and in South America, where they are known as the **llanos,** they cover the basin of the Orinoco, north of the selvas of the Amazon.

Deserts. Where the rainfall is under ten inches, vegetation is very scanty and extensive areas are entirely bare, covered with sand. Passing on farther polewards from the savannas, there is decreasing rainfall in the continental areas and on the western margins. The savannas are therefore succeeded by semi-deserts or scrubland, and these in their turn by deserts. The dry trade winds are largely responsible for these tropical deserts, but their extension into the temperate latitudes of central Asia is due to the extreme dryness of the air and the high summer temperatures, on account of their being situated far in the interior.

Occasionally in desert regions, a rain-storm may occur and supply moisture which the few plants found here and there seize upon for their rapid growth, while the dew resulting from the great and quick cooling at nights is utilized by them for maintaining their growth. Desert plants have naturally many devices for storing water and checking transpiration in an effort at adjustment with the dry environment ; the cactus, a typical desert plant, has in its thick and fleshy stem and spiny leaves such a device for conserving the moisture-supply. Underground water when it comes close enough to the surface, and the waters of a river which flows across the region from a wet area, produce a change in the vegetation, which though retaining its desert characteristics, consists of shrubs and small trees and patches of grassland here and there. Such conditions are often found on the borders of deserts, where the region is spoken of as scrubland or semi-desert.

Such semi-deserts are found in India west of the Aravalis, and on the borders of the Thar desert except where, as in the

Punjab, and in parts of Sind, irrigation schemes have been extensively developed, converting the arid lands into smiling fields of wheat and cotton. In Africa, the grasslands of the Sudan pass into a scrubland which soon gives place to the true desert—the Sahara, which extends from the Red Sea coast to the Atlantic and occupies an area larger than the whole of India. On the northern borders of the Sahara there is scrubland, which changes into the Mediterranean type of vegetation found on the northern coasts of Africa. There is another desert area in Africa, the Kalahari desert, in the southern latitudes, which corresponds to the Sahara. In Australia, large areas of the centre and to the westward of it are very extensive deserts with the Australian bush on their borders. In North America too there are patches of desert and semi-desert ; and in South America, the presence of the Andes makes the south-east trades part with their moisture in the lands to the east, so that on the western coast there is the Atacama desert of Chile, well known for its great nitrate deposits. The dry belt which includes the Sahara extends north-eastwards to a considerable distance, even to temperate latitudes, and includes Arabia, the Iran plateau, Turan, Tibet and Mongolia. Of these areas, the deserts of Arabia and of Gobi in Mongolia are the largest ; very little cultivation is possible except where underground water can be tapped by wells. This extensive dry region is a land inhabited chiefly by nomads wandering with their flocks in search of fresh pastures.

Temperate grasslands. Farther polewards from the semi-desert and the desert, there are continental areas which have hot summers and a moderate rainfall. The subsoil is usually dry ; large trees are absent ; the lack of moisture, the loose soil and strong winds, all contribute to the absence of trees and to the growth of grasses which grow and flower in spring and early summer, but wither and die down with the increase of heat in late summer. In Asia, such temperate grassland is found east of the Caspian Sea, where the areas are known as **steppes.** In North America, the central continental areas belong to this type, where they are called **prairies.** The prairies, however, have been developed much better than the steppelands of Asia, largely because of transport facilities and a more advanced people and government, so that they produce large quantities of wheat and maize. In South America, similar regions are called the **pampas**, which cover a large part of the Paraguay basin. The Australian grasslands are found in the basin of the Murray-Darling, on the leeward side of the Great Dividing Range. A large part of Europe removed from the sea influences was at one time grassland, but intensive cultivation and high farming have replaced the natural vegetation of that continent.

While savannas are suitable regions for advanced agriculture, the prairies and steppelands are also generally suitable for sheep-rearing and stock-raising, so that in Australia, the veldt in South Africa, Argentina and Asia, such regions have become noted for their wool, meat and skins, as well as for the grain crops.

Evergreen forests. On the margins, the rainfall is more plentiful than in the interior, and in the high pressure region of the horse latitudes, the shifting of the winds brings this rain on the west in winter when evaporation is not great, so that the subsoil remains moist. The summer drought has of course to be carefully guarded against, and for this purpose the plants develop devices for adaptation. The trees are small and evergreen in type, the leaves being often of an olive-green colour ; the leaves are tough-skinned and in some cases rolled back ; the roots are long and deep and are often bulbous. The hot, dry summers are useful for the proper ripening of fruits. Where the rainfall is most plentiful, a forest develops. The **Mediterranean vegetation** is thus distinctive in having evergreen forests. The cork-oak of Portugal and Morocco is well known ; the olive, myrtle, laurel and cypress are typical trees; and **fruit trees,** such as the orange and the fig, abound.

Deciduous forests. Farther from the evergreen forests of the Mediterranean zone, and on the eastern margins of the sub-tropical zone, the rainfall is fairly abundant, over twenty-five inches, and well distributed through the year. Forests in these regions have deciduous trees, broad-leaved, shedding their leaves in the dry season ; such trees are the oak, beech, elm and maple. Their inflorescence is inconspicuous ; they do not develop many species ; the undergrowth is not dense, and their growth is arrested in the colder months on account of winter frost. Central Europe, the eastern parts of North

America, and Japan are covered with such deciduous forests, which are also found in south-eastern Australia, New Zealand and southern Chile. In China, the forest area extends towards the equator into a warmer region with greater rainfall, and becomes an intermediate type between the equatorial and temperate forests.

Coniferous forests. Farther polewards, rainfall decreases in quantity, but is still well distributed through the year. The winters are cold and long ; the summers are cool and short ; the rains are scanty, but evaporation is not excessive, and the broad-leaved trees give place to coniferous varieties. In these coniferous forests small and needle-like leaves are characteristic, and the fruits are hard cones. The leaves are not all shed at one time, but many are retained during the winter as a protection. The typical trees of such coniferous forests are the pine, fir, hemlock and larch. The birch, though broad-leaved and not cone-bearing, occurs commonly in these regions. These forests are to be found in the cool temperate regions of North America, Europe and Asia ; they supply soft timber such as **deal,** which is so useful for the manufacture of match splints and boxes and for packing cases, as well as for pulp used for paper-making. They also yield useful products like resin and turpentine. Coniferous forests are also found in mild, wet regions, where usually deciduous forests would be favoured, but dry soils or the colder highlands of central Europe and the Himalayas have induced the growth of coniferous types in preference to the deciduous.

Tundras and ice-deserts. Beyond the coniferous forest belt, arctic conditions prevail ; the summers are cold and very short ; the winters are very cold and very long ; snow-fall succeeds rainfall ; the subsoil is permanently frozen ; only the surface thaws during the brief summer. The coniferous forest merges into a region of small tough bushes which again change to a great variety of mosses and lichens. In the short summer, the days are long. Sheltered valleys and south-facing slopes have brilliantly coloured flowers, the plants completing their life-cycle in a few weeks. All along the Arctic coasts in North America, Europe and Asia, these **tundras,** as such regions are termed, are found. The characteristic animal is the **reindeer** which feeds upon the mosses, and the population is very sparse. Farther on, the tundra merges into the **ice-desert,** where the land is covered over with perpetual ice and snow and where no vegetation can grow. Such ice-deserts are found in the interior of Greenland, on the Arctic islands and on the Antarctic region around the South Pole.

Mountain vegetation. Temperature not only decreases with latitude, but also with altitude, and profoundly affects the type of vegetation on the slopes of mountains. From the equator to the poles, vegetation changes from the equatorial forest to the ice-desert; and we get the same succession of vegetation types as we ascend a high mountain near the equator (Fig. 74). At the base of the mountain there is

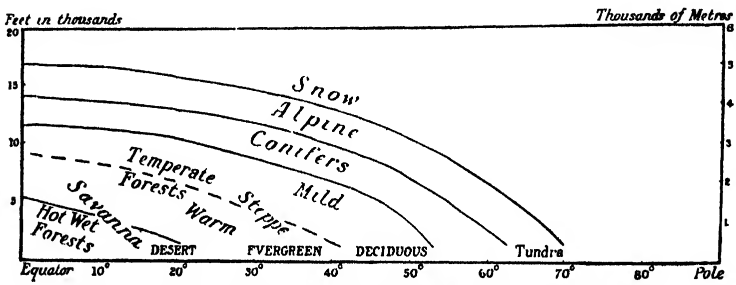

FIG. 74. Horizontal and vertical girdles of vegetation

the equatorial forest which, as we climb, gradually merges into the temperate deciduous forest, and the jungles of palms, bamboos, tamarinds and pipals give way to oaks, beeches and maples. These give way in their turn to the pines, firs and larches of the coniferous forest region. At very high altitudes, the rainfall decreases, owing to the very low capacity of the colder and rarefied air for absorbing water-vapour. Stunted trees, shrubs and bushes become more numerous. High valleys and the regions irrigated in spring by the melting snows have meadows with grasses and flowering plants. Higher still the shrubs and meadows are succeeded by the dry and cold region like the tundra, beyond which are fields of everlasting snow and ice. Thus a mountain will exhibit the same succession of vegetation belts, starting at the base with the one which is natural to the low plains in those latitudes. Thus the Himalayas present successively the same change of plant type from the monsoon jungles at the base to the ice-deserts on the mountain tops at and above the snow-line, as those we encounter on a journey from the tropics towards the poles. Lofty plateaux like those of Tibet and Bolivia are arid regions with the characteristic semi-desert vegetation with bushes and grasses here and there.

Shifting of vegetation belts. It is important to realize that while the vegetation belts remain in the same relative position, their extent and situation have undergone considerable changes in the course of ages in harmony with climatic changes. Sun-spots reach maximal numbers every eleven years, and changes in them are reflected by changes in the climate of different parts of the Earth. These eleven-year periods, however, form a part of a system of variations, much longer and more extreme, which are responsible for the gradual shifting of the climatic and vegetation belts. The ruins of cities and cultivated fields in desert areas, and the remains of irrigation works in wet areas can only be explained by the assumption of the progressive desiccation or the increased precipitation in different regions on the Earth. Large areas in central Asia are being desiccated, and large migrations of people take place from them; the desert has advanced, causing the decay of the great cities of Babylonia and Assyria; and tropical forest has spread farther to crush out the ancient Maya civilization.

Migration of plants : carriers and barriers. Different plants have distinctive requirements of soil and climate, and a given plant would not grow under widely different conditions. But within narrower limits, particular species and varieties can thrive in different lands with the same or even with slightly different climatic conditions. The distribution of plants therefore is altered owing to the action of different **agents. Wind** blows away the seeds of plants, carries them away for longer and shorter distances, where they germinate and establish themselves if the new surroundings are not altogether adverse. Seeds are similarly carried, even over long distances, in some cases, by the **water of rivers and seas,** so that opposite coasts of seas often have the same or similar species of plants. **Birds** too form an agency for the distribution of plant seeds, which they swallow, and throw out sometimes after flying considerable distances. It must be realized, however, that while wind, water and birds are useful agents for plant migrations, there are **barriers** which effectively prevent such movements. The **oceans** are too vast for seeds to be carried or wafted across them to the opposite shores; the **mountains** are too high; the **deserts** are too dry. These therefore act as barriers to the migration of plants, so far as wind, water and birds are concerned; but they cannot prove great obstacles in the efforts of man to promote or effect such migrations of particular types, species or varieties of plants. **Man** helps to change the distribution of various species and varieties to a very marked extent. By manuring and soil improvement, the deficiencies of the soil are made good for particular plants to thrive; irrigation, by the building of dams and the construction of canals, makes up for the deficiencies of rainfall; and man even bores artesian wells to draw forth the underground supplies of moisture needed by plant life. More than this, man has brought plants from one country to another where they find a suitable home with acclimatization. The potato and tobacco were thus brought over from their original homes in America by the early European colonists, and these plants are now thriving in India and other countries where they have been introduced. Maize is similarly a gift of the New World to the Old, while rice is Asia's gift to the world. The importation of better varieties of cotton, ground-nut, sugar-cane and rubber, and the acclimatization of such exotics in India and other lands has been, and is being effected, so that man has proved to be a great modifier of the original distribution of plants on the surface of the Earth. Indeed, vegetation is so useful to man, that it is no wonder to find him constantly trying to introduce new varieties and new types in regions different from their original homes. The cereals and pulses, like rice, wheat and **tur dal,** furnish him with food; the fibres, cotton, linen, hemp and jute, serve him for clothing and packing; the forests give him timber for shelter, for house and boat building; tea, coffee and cocoa give him his beverages; seeds supply him with table oils, illuminants and lubricants; cinchona, opium and several others with drugs and medicine; and a great many plants are utilized as raw materials for the great manufacturing industries which meet the increasing wants of civilized men.

3. ANIMALS AND THEIR DISTRIBUTION

Animals are either carnivorous or herbivorous. Animals of the latter class depend on the supply of vegetation, and on their members those of the former class depend. Thus, directly or indirectly, animal life is influenced largely by supplies of water and vegetation available in different regions. But the clearing of jungles, the taming and rearing of useful animals and the hunting of wild animals have powerfully affected the number and the range of the various species. Thus, tigers, leopards and wild elephants have decreased in number in India, and the Indian lion is found nowhere except in the Gir forest of Kathiawar.

In every region, there is a very large assemblage of low forms of animal life, the invertebrates, insects, molluscs and worms, which feed on fresh and decayed vegetation. Birds, reptiles and even the small mammals feed on these. But the number of large mammals, the bigger carnivora, and the great birds of prey is relatively small. The resting period in the vegetable kingdom cuts off the food-supply and thereby leads to a suspension of activity in many forms of animal life ; these then pass the period in the form of eggs, or in a state of suspended animation ; and the animals feeding upon them have, in consequence, to hibernate or migrate. Thus ducks, snipe and other birds visit India every winter, migrating from cold Siberia and other far-off lands.

Animals show a marked ability to adjust themselves to varying conditions of life in the different regions, and it is not possible to divide the world into such definite natural animal regions as can be done as regards vegetation. But animal life in each natural vegetation region exhibits distinctive features and marked peculiarities.

Forests. The **equatorial forests** are hot, damp and dense, with a thick undergrowth, so that animals there must possess marked flying or climbing abilities. Bird and insect life finds very favourable conditions for development and there are great numbers of monkeys, apes and tree-living animals. Even amphibians like frogs and reptiles, snakes and lizards, have adjusted themselves to a tree life. Among the animals in these forests which cannot climb or fly is the elephant, but he is endowed with strength enough to force a passage through the dense forests. In the **monsoon** jungles, animal life is similar and we have the elephant in the forests of Burma, Kashmir and Mysore. In the more open forests tree life has not the same major importance, and animals like tigers, leopards and bears, who live on the ground, are more numerous. In the **temperate regions,** the forests have various species of wild cats, squirrels, opossum and flying foxes, which are well adapted for life in trees, and wild boars and wolves, as, for example, in Europe. In the **coniferous forests,** the animals are particularly useful for their rich furs.

Grasslands. In these regions we find the grazing animals, like the ox, horse, zebra, antelope and deer, which move about in large flocks and herds. There are also the larger beasts of prey like the lion, tiger, hyena and jackal. It is interesting to observe how animals in each region are adapted to the conditions prevailing there. The grazing animals have no particular means of defence against their natural enemies, the great carnivora ; but they can move very rapidly, so that they can elude their enemies and can cover long distances in search of water and grazing grounds. Birds like the ostrich in Africa and its counterparts, the rhea, emu, and cassowary in South America and Australia, are also found in the scrublands bordering the savannas, and as these birds cannot fly, they run very swiftly. The scanty rainfall leads to the development by plants of underground stems and long roots ; and small animals, like the rodents, live in large groups in burrows underground, for food-supplies, for protection against the extremes of temperature, as well as for safety from the carnivorous animals which prey upon them.

In the temperate zone, animal life shows marked seasonal migrations and changes. The larger animals migrate towards the poles or go up mountains in summer, and towards the equator or down to the valleys below in winter. They also move with the change of seasons, from wet to dry, towards or from river valleys. The smaller animals, however, are considerably reduced in number or they pass the time in sleep in cold or dry seasons.

Animals are very commonly protected against their enemies by **suitable colouring.** Smaller and weaker animals can get sufficient cover, during the growing season, in the high grasses, and shrubs, while the striped body, and the brown and tawny colouring of the larger animals so harmonize with the general aspect of vegetation that they are not easily distinguishable from a distance.

Deserts. Vegetation here is very scanty and can hardly support anything but a few insects and burrowing animals, a few reptiles and birds. To suit the environment, the colour of the animals is yellowish-brown. The camel, also similarly coloured, is the 'ship of the desert'; with its broad, padded hoofs, it travels swiftly across the yielding sands of the desert; and even in its habits as regards food and drink, it is remarkably well adapted to desert conditions. In the desert oases of Rajputana, in the semi-deserts of Sind and the north-western frontier of India, we see strings of camels, functioning as the agents of transport for the trade between India and the countries beyond its land frontiers.

Tundras. The long and severe winter and the short cool summer lead to a very peculiar type of animal life. The thawing of the surface in summer leads to the breeding of numerous insects, which attract flocks of birds polewards; the surface is covered over with mosses and lichens on which the reindeer and elk feed. Special protective colouring is very characteristic of the rigours of climate in this region. The arctic fox changes from brown in summer, to white in winter, to harmonize with the snow-covered lands, while the polar bear, which feeds on fish and seals in the sea, has a white coat.

Oceans. On the seashores we find a large number of sea birds, which live on fish or the small sea animals left on the beach by the receding waves. The shallow waters of the continental shelf have plenty of vegetation which provides food for a large number of fish and marine animals, and are excellent fishing grounds. Thus round the shallow coasts of India, Great Britain and other countries, fish are abundant, and fishing becomes an important occupation of the people in the coastal regions. In deeper waters, there is peculiar vegetation and peculiar animals, the most important of which is the whale. At great depths, light does not penetrate at all; vegetation is absent and the marine animals therefore feed on decayed plants and dead animals that sink from the upper levels.

The large sea animals, the whales, walruses and seals, are very useful to human beings for their oil and bone, ivory and skins. Other sea creatures also yield useful products like lime from shells and coral, pearls from oysters, shells from turtles, and oil and manure from fish. The south-western coast of India near Calicut provides an example of the last-named.

Animal migrations. Unlike vegetation, animals have the power of movement, and their distribution over the surface of the Earth is not therefore permanent. Animals move about in convenient regions, but the great barriers that obstruct the migrations of plants also check the migrations of animals, and oceans, mountains and deserts are great barriers to their movement, so that animal life, on the opposite shores of wide oceans, high mountains and great deserts, differs, often very considerably. But these barriers do not come in the way of the interference of man who has been able to modify animal distribution a great deal. The horse, ass, sheep, camel, cow and dog have all been introduced to regions often far distant from their original homes. The introduction of the merino sheep into South Africa and Australia, of the silk worm into northern Italy, of the Angora goat, which yields mohair, into South Africa and of the camel into Australia are striking illustrations of the modifications which man has been able to introduce in the distribution of animals. Yet, natural

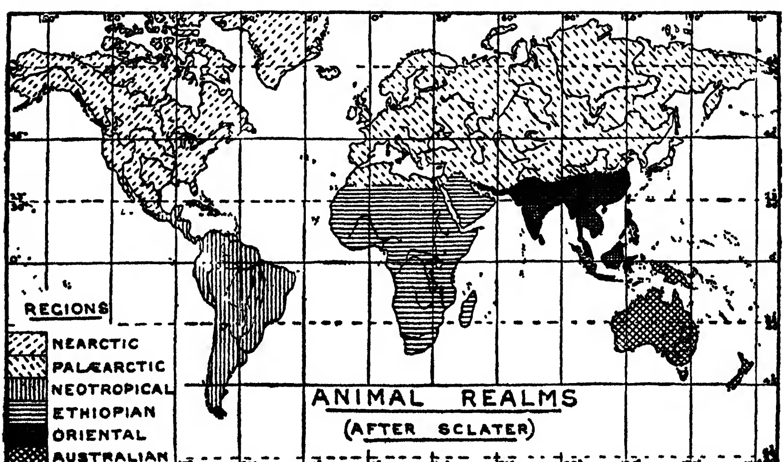

FIG. 75. Animal realms

barriers *do* exercise considerable influence and give rise to five major divisions of animals or **zoo-geographical** regions.

Zoo-geographical regions. The **Palearctic region** includes the arctic animals in Eurasia, north of the mid-world mountain system. The reindeer typical of the tundras, the yak of the Himalayan regions, the whale, walrus and seal of the Arctic Seas, the wolf and the bear all belong to this group.

The **Nearctic region** is the temperate part of North America. The animals are very similar to those of the Palearctic region, for there is much evidence, both geological and zoological, to show that not long ago there was free land communication between the Old and New Worlds in the northern hemisphere across what is now the Bering Strait. The caribou, musk ox, black bear, beaver and bison are distinctive animals of this region.

The animals of these two regions show a marked difference from those of tropical Asia and of tropical Africa. To some extent, this difference is doubtless due to the existence of transverse mountain chains such as those of the Himalayas and the Alps ; but it is also largely the result of the existence of a great band of deserts and wastes across Asia and northern Africa, for both the mountains and deserts prevent intermixture.

The **Oriental region** includes India with farther India and a few islands of the Malay Archipelago. In this region, we have the anthropoid apes, the orang-outang of Sumatra and Borneo and the gibbon of the Malay region and many kinds of monkeys. The carnivora are numerous, and include the bear, the tiger and the other great animals of the cat family. The presence of oxen, the paucity of antelopes, the abundance of deer, the presence of many pigs, the rhinoceros, tapir and elephant, large numbers of rodents like the squirrel and mouse, birds with gay plumage like the peacock, singing birds like the bulbul, many reptiles like the cobra, flying lizard and crocodile are all features of animal life in this region.

The **Ethiopian region** is zoologically very similar to the Oriental. It includes Africa south of the Atlas mountains and Sahara desert. The fauna of Madagascar is so strikingly different that sometimes it is classed as a distinct region, the

Malagasy region. The Ethiopian region has among the primates, the gorilla and the chimpanzee; monkeys and lemurs are represented by several species. The bear is absent, the lion abounds; goats and sheep and true pigs are practically absent, though there are river hogs and the hippopotamus. There is no tapir, no camel; but rhinoceroses, elephants and several kinds of horses occur, as well as peculiar forms like the giraffe and okapi. Antelopes are abundant. Birds are not so abundant nor so beautiful as are those of the Oriental region. Madagascar has striking differences from the mainland owing to its long isolation. The insectivora and lemurs abound; the carnivora are few and small. The absence of the true cats of the genus **felis,** elsewhere so widely distributed, is a remarkable feature. The Ethiopian region is decidedly the region of large quadrupeds.

The **Neo-tropical region** includes South and Central America with Mexico and the West Indies, and is distinctly peculiar and very rich in species. Here are no anthropoid apes, no dog-faced monkeys, no lemurs. The fruit-bats of the old world are absent; the vampire bat is found only here. Insectivores are practically absent. The lion and tiger here find their counterpart in the puma and jaguar, the camel in the llama and the ostrich in the rhea. The alpaca and condor represent peculiar animals of the Andes, while the tapir or ant-eater is also a characteristic animal of the region. Among the reptiles, interesting forms are the rattlesnakes, the boas and anacondas.

The **Australian region** is separated from the Oriental roughly by Wallace's line, drawn between the islands of Bali and Lombok in the East Indies. A narrow but deep strait separates these islands, and Wallace believed that all islands to the east of this strait possessed faunas with a distinctively Australian *facies*, while those to the west had faunas of the Indian type. As a matter of fact, however, there is no hard and fast line, and a transitional zone must be accepted in the East Indies. The Neo-tropical and Australian faunas show considerable affinities. The marsupials, so characteristic of the Australian region, are also found in South America, which has many kinds of opossum and other types, and there are increasing proofs of the probability that Australia and South

America were connected, at one time, through the Antarctic continent. The marsupials, of which the kangaroo is the most familiar representative, are ordinarily numerous and very diverse, adapted to almost every kind of habitat. The higher mammals are absent, with the exception of the dingo or wild dog. The birds of this region are interesting and peculiar. They are songless, though of very fine plumage. The bird of paradise, the bower-bird and the lyre-bird are remarkably beautiful; the parrots are exceedingly numerous and very characteristic, while the related cockatoos are almost peculiar to the area. Very striking also are the running birds like the curious little apteryx of New Zealand and the emu and cassowary of Australia. Many ancient forms exist in this region, and suggest the long isolation of Australia and account for the extraordinary differences between its fauna and that of the rest of the world.

Animals are of great use to man for various purposes. Several, like the ox in India and the horse in Europe, are used for agriculture; others, like the ox, donkey, mule and even the elephant in jungles, are beasts of burden. Some, like the ox, horse, camel and reindeer, are utilized for commercial transport, while others provide sport for the hunter. Cattle, sheep, goats, pigs, and fish yield food for man, while most animals yield valuable raw materials of importance in the commerce of the world, such as wool, hides and skins, oil, bones, feathers, furs and fibres.

CHAPTER V

THE NATURAL REGIONS

THE land surface of the world is divided into continents, each continent is divided into countries, and each country into smaller administrative areas known by different names in different countries. India is divided successively into provinces, divisions, districts and talukas. The principle underlying the division in the case of continents is that of geographical isolation. Most continents are separated from the others by vast stretches of water, each has distinctive physical features and plant and animal life, and has developed through its history and course of development a unity that marks it out from the others. Europe and Asia, however, are not so well separated as the others are, and geographically these two are often regarded as the Eurasian continent, Europe being the western projection of the large land mass of Asia. There is some evidence of distinctness effected by the low Ural mountains (although the boundary of the old Russia in Europe was to the east of the Urals), the low depression of the Manych Gap between the Urals and the Caspian Sea, the Caucasus mountains and the seas of the Mediterranean area ; and the climate, products, history and development of these two have been so different, that it is generally held better to treat them as separate continents.

The large continental divisions that man has recognized for ages, are thus natural divisions of the Earth's land surface. But the division of continents into countries is not always based on natural factors. Though in a general way these countries are often distinguished by some distinctive natural peculiarities of relief, climate and natural resources, they represent areas under different governments, and are therefore political divisions. Political boundaries do not always coincide with natural ones, and countries do not therefore show the homogeneity of conditions of life which is characteristic of natural regions. In the study of general geography, the importance of regional studies is being increasingly recognized; the fundamental unity of a natural region is appreciated; and even where countries (that is, political units) are studied, the political or administrative divisions into provinces, districts and talukas are ignored in favour of natural subdivisions into smaller and smaller units. The influence of geographical conditions is, however, so strong that political divisions tend to approximate to natural regions.

The visible sign of the homogeneity of a region is afforded by a common language and, in general, linguistic divisions correspond to natural regions and tend to be identical with administrative divisions within a country. The separation of Burma from India, of Orissa from Bihar, and of Sind from the Bombay Presidency illustrates very clearly the strength of the language factor which is really the result of the geographical unity of the natural regions. In course of time, the same tendency will probably lead to the creation of a separate Carnatic province, and perhaps to the separation of Gujarat and Maharashtra.

In a broad general survey of the world we are concerned only with the larger divisions; the small divisions can properly be studied in considering the separate continents and countries. The fundamental basis for a division of the world into broad natural regions is the temperature conditions, for it is these that profoundly influence the climate and therefore the natural resources of different areas. Thus, as we have seen in an earlier chapter, we have five main regions, the equatorial, the tropical, the sub-tropical, the cool temperate and the polar, approximately bounded by the latitudes of 0°, 10°, 30°, 45° and 60° north and south, respectively. But the proximity of the sea makes a considerable difference in physical conditions, and each one of these five regions should fall into three sub-regions, west marginal, interior and east marginal, the features on the two margins being generally different. Thus, there should be fifteen natural divisions; but the nearness of the sea makes little difference to the two regions in the equatorial and polar regions, and we need not there consider the margins separately. The number is thus reduced to eleven. The third factor influencing temperature must now be considered, namely, altitude; but on the margins, this factor can be safely ignored and it is only in the interior lands where we can fruitfully distinguish between the lowlands, highlands and the very high lands, and even then in the equatorial and the polar regions, the distinction between the high and very high lands might be omitted. Therefore we have only nineteen main natural regions of the world as under.

I.	Equatorial	1. Lowlands (or Amazon type). 2. Highlands (or Malay type).
II.	Tropical	3. West marginal lands (or Sahara type). 4. Interior lowlands (or Sudan type). 5. Interior highlands (or East African type). 6. Interior very high lands (or Ecuador type). 7. East marginal lands (or monsoon type).
III.	Sub-tropical	8. West marginal lands (or Mediterranean type). 9. Interior lowlands (or Turan type). 10. Interior highlands (or Iran type). 11. Interior very high lands (or Mongolia type). 12. East marginal lands (or China type).
IV.	Cool temperate	13. West marginal lands (or west European type). 14. Interior lowlands (or Siberian type). 15. Interior highlands (or Atlas type). 16. Interior very high lands (or Tibetan type). 17. East marginal lands (or Manchurian type).
V.	Polar	18. Lowlands (or tundra type). 19. Highlands (or Greenland type).

Equatorial regions : lowlands. These are uniformly warm and moist and have dense impenetrable forests with occasional patches of rich wooded parklands. Tall trees, festoons of interlacing creepers, a dense undergrowth almost a forest by itself, and the great struggle of the plants for sunlight are characteristic features of these regions. The whole

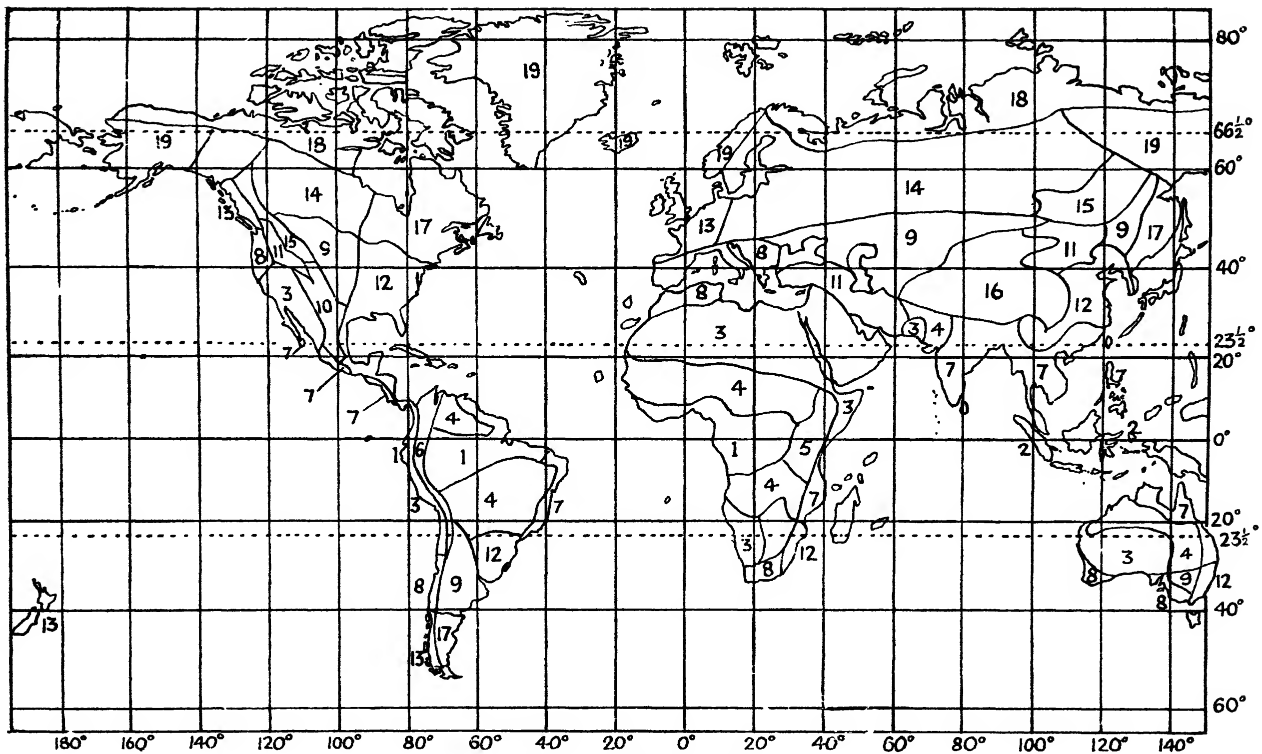

FIG. 76. Natural regions

area is traversed by streams and watercourses, which form the great rivers which in the seasons of maximum rain expand into large inland seas. Among the important forest products are rubber in the Amazon and Congo basins, gutta percha in the East Indies, the oil palm of the Guinea coast and cabinet woods such as ebony and mahogany. The climate is unsuitable for European colonization, but with the progress of medical science and the researches into tropical diseases, the problem of tropical and equatorial colonization by Europeans has been increasingly attracting attention since other regions have become progressively occupied.

Mountainous island type. In the Malay Peninsula and the islands of the Malay Archipelago similar forests are found in the lowlands, while on the higher ground the vegetation is of the savanna type. The temperature is high, and rainfall is abundant and distributed throughout the year. In the Netherlands East Indies, particularly in Java, the enterprise of the Dutch colonists has led to great developments in agriculture, and large plantations have succeeded in yielding useful crops such as sugar, cinchona, tea, coffee and rubber. Spices are obtained in great quantities from the forests. The sago-palm is the chief food plant of the native tribes and the tapioca is also of peculiar importance.

Tropical lands : western margins. On the western margins there are the great deserts, very hot and dry and almost without life, vegetable, animal or human, except in the fertile oases. They lie in the track of the trade winds ; the range of temperature between day and night, and between summer and winter is very great. A thick growth of palms marks the oases where the shade makes possible the production of some cereals and fruits. The people inhabiting the margins and oases of the Sahara and Arabian deserts have attained a fairly high stage of progress and commercial development, but isolation has kept the Australian desert-people more backward and primitive. These desert lands, the lands of the date and the camel, are believed to be rich in minerals, and the Atacama desert of Chile certainly has large deposits of nitrates of great value.

Interior lowlands. In the inter-tropical lands of Africa there is a heavy summer rainfall ; the temperature varies with elevation ; and the vegetation is of the savanna type, well marked in southern Sudan. Numerous trees like the gigantic baobab, interspersed with tall grasses, herbs and bushes, give these tropical grasslands the appearance of a large park. They are generally suitable for cattle-rearing, and the people are largely pastoral, but agriculture is developing under the influence of European settlers, particularly in coffee and cotton.

In South America, extensive grasslands are found in Northern Colombia, western Ecuador, the Orinoco basin, (known as the llanos), the Guiana highlands, the campos of Brazil and the pampas of Argentina. Near the equator, savannas are found only on the highlands, but in Argentina they are on the lowlands. Cattle-rearing is a typical occupation in these lands. In the hot lowlands, the cultivated plants are rice, bananas and tropical fruits, cacao and sugar ; coffee, cereals and fruits are raised in the cooler highlands. The northern part of Australia is a savanna region where very similar products are obtained. The Australian savanna region is less extensive than the similar regions in Africa and South America.

Highlands. The highlands of the tropical region are represented by the east African plateau, which has lower temperatures and less rainfall than the Sudan. The grasslands there are pastoral, but many crops can be grown at different altitudes. Cotton and other fibre-plants grow well where the rainfall is not heavy. This region is being colonized by Europeans, and Indian settlers have also gone there in large numbers. It is, therefore, of great interest to India for colonial expansion and as an outlet for her surplus population.

The high plateaux of Ecuador, though in equatorial latitude have, on account of their elevation, temperate climate belts at different heights. On the plateau on which stands Quito, wheat and other cereals do well at a height of 9,000 feet. These plateaux are much nearer the equator than the still loftier plateaux of Tibet and Bolivia.

Eastern margins. These lands are under the influence of the great periodic winds, the monsoons, which are typically developed in India. In summer, which is the wet season, the winds are inflowing; in winter, the dry season, they are outflowing. The windward slopes of the Western Ghats receive heavy rains, and are densely forested. In the east, the monsoon sweeps northward across the Bay of Bengal and is drawn north-westward along the Ganges valley; the south-east of the peninsula receives rain in winter from the north-east trades which advance across the Bay of Bengal on the retreat of the south-west monsoon. Southern China is on the border of the monsoon region and the products of India and southern China are very much alike. Rice is grown in the lower courses of large rivers; wheat in the upper basins of the Narbada and the Ganges-Jumna, and also extensively under irrigation in the Punjab; and millet, **bajra** and **jawar,** in the drier plains. Many commercial crops like cotton, tea, tobacco, sugar and jute are cultivated. In the Indo-China peninsula the highlands are covered with monsoon forests yielding teak, a very valuable timber, and bamboo which is useful for paper-making and for furniture.

Central America and the Guiana lowlands are in a more or less similar region. There are rich forests of mahogany, logwood, palms and bamboos; tropical fruits like the banana and the pineapple abound; and cacao, sugar, coffee and maize are important products. The West Indies have similar products, though the different islands exhibit different varieties and some peculiarities.

Sub-tropical lands. These warm temperate lands in the northern hemisphere stretch across North America in a continuous belt; but in Europe and Asia, the continuity is broken by high mountains. These lands stretch across the narrow part of South America, and are found in the southern parts of Africa and Australia. The rainfall varies with the season. In the west, winter rains are important; in the east, summer is the rainy season and the interior receives little rain.

Western margins. Here the climate is peculiar, with a wet winter and a dry summer, and irrigation is necessary in the dry summer. Evergreen vegetation is the chief feature. The chestnut and walnut do well in the higher parts where the rainfall is sufficient. The characteristic products are fruits, such as grapes, fig, mulberry and apricot, cereals such as wheat, fibres such as cotton and seeds like the olive. Grapes are made into wine, or are dried into raisins and currants; orange groves are much in evidence in Spain and Italy; figs are important in the Levant. The Mediterranean lands of the Old World played a very important part in the history of civilization and the progress of commerce. Egypt, Phoenicia, Greece, Carthage and Rome have all been centres of civilization in earlier times, before the discovery of the New World ushered in the ocean stage of civilization. The construction of the Suez Canal restored some of the importance of the Mediterranean Sea, which links up Europe with the Far East, Australia and eastern Africa.

In North America, the Mediterranean type is confined to the narrow valley of California, which produces wheat and other characteristic products under irrigation. Central Chile in South America, the western part of the Cape of Good Hope in South Africa, and certain areas in the southern parts of Australia belong to the same type.

Interior lowlands. From the Black Sea to the Pamirs in Asia, the Great Plains from about 100° W. to the Rocky mountains in North America, a great part of Argentina in South America, and a large part of south-eastern Australia, are the areas included in this region. The climate is extreme, the rainfall is scanty. The Eurasian lands are semi-deserts, except where irrigation is possible, when cotton, fruits and cereals are grown; but in the New World they are great pastoral regions, and are important for wool, meat and skins.

Interior highlands. In the temperate latitudes of Asia, from the Mediterranean to the frontiers of China, are found a series of plateaux intercepted by high mountains. Very extreme climates are experienced and the rainfall is very scanty. Sheltered valleys irrigated from the mountain streams are the only parts that can be cultivated, though even there, vegetation is never rich. Much of this region is therefore salt or sandy desert. In the fertile valleys some cereals are produced and fruits such as apricots, peaches and almonds are grown; a good part of the fruit is dried for winter use and for export. The Great Basin of North America, with high plateaux enclosed between the ranges of the western cordillera, is a region of this Iran type: dry, unproductive and sparsely peopled. The plateau of Mexico, tropical by latitude, is yet temperate by altitude, and the products vary with the height and irrigation facilities. The absence of large rivers makes irrigation difficult, and a large part of Mexico remains semi-desert with pastures suitable only for sheep and goats. The cactus and the hennequin, from which a strong fibre is obtained, are cultivated in the drier parts. At heights where there is a warm temperate climàte and water is available for irrigation, rice, sugar, cotton, coffee and cacao are grown, while temperate products like maize, wheat, and tobacco are grown at greater heights.

Mongolia is still worse off. It has cooler summers, much colder winters and it is practically rainless. It is therefore largely desert or scrubland relieved only by a few oases here and there.

Eastern margins. The characteristic region of this type is central and north China. The summers are hot and rainy, the winters are cold and dry. There is some similarity in products to those of the Mediterranean region; the walnut, camellia and laurel do well. Cereals and pulses are raised as early crops; sugar, rice and cotton as summer crops. Tea is important in the south on hill slopes; while the opium poppy and mulberry also flourish very well. Japan is on the northern fringe of this region, the south-west having a fairly uniform rainfall throughout the year. In North America, the China type of region is met with from the Atlantic coast to the Mississippi, and maize, tobacco, cotton and rice grow very well. Natal, the eastern part of the Cape of Good Hope, eastern New South Wales and southern Queensland, all belong more or less to this type, and with development ought to be able to produce all the crops characteristic of this region.

Temperate region. The cool temperate lands are almost confined to the northern hemisphere, where they form a continuous belt across Eurasia and North America. Southern Chile, New Zealand and Tasmania are the only parts in the southern hemisphere which belong to this regional type. Cool summers with cold or mild winters characterize this region, the severity of the winter depending generally on the latitude, but even more on the distance from the sea. The western borders benefit in rainfall from the westerly winds; but the interior and leeward slopes of mountains suffer from a very scanty rainfall. Wheat is the characteristic product of the temperate belt.

Western margins. These include western Europe, with the western part of Scandinavia, British Columbia in North America, south-western Chile, New Zealand and Tasmania. Norway and British Columbia are both mountainous lands to which the westerlies give heavy rains at all seasons, but especially in autumn and winter. Fishing and forest industries are consequently more profitable than agriculture. Great Britain, northern France and Germany have fairly similar conditions. Towards the east, summers become warmer and the winters colder, but sharp extreme climate is not met with. Western Europe was once covered with forest, but man has greatly changed the natural vegetation. Coniferous trees form the forests of northern Europe and of the central European highlands, the Black and Bohemian forests, while deciduous trees form those of the lowlands of central Europe. The forests have now been largely cleared in Britain and central Europe and many useful crops are cultivated. Wheat of course is extensively grown ; and the potato—originally found in the New World, and almost universally used for food and for distilling spirits—and the sugar-beet are important root crops. The fibre crops are represented by hemp and flax. The dry parts at higher altitude provide pastures for sheep which are reared both for their wool and flesh ; and the richer grasslands below provide grazing grounds for cattle and horses.

Interior lowlands. Siberia is the typical interior temperate lowland. The climate is extreme, the winters being long and severe and the summers short and hot. The summer rainfall decreases rapidly towards the east, though in the corresponding belt in North America (Canada) the decrease is towards the west. Passing southwards from the tundra, we have a poor woodland which soon merges into great coniferous forests, the **taiga.** These are succeeded farther southwards by woodland merging into the grasslands or steppes or prairies in both continents. They have been the home of nomadic people ever on the move with their herds and flocks in search of fresh pastures. Huge herds of bison and large bands of Red Indians (North American Indians) roamed over the American prairies, but the bison has nearly disappeared and the Red Indians have decreased greatly in number. Improved methods of agriculture are bringing a larger area under cultivation in these latitudes, and Siberia is also quickly responding to the organized efforts of the government and developing rapidly as a great wheat-producing land. The southern continents do not reach these latitudes, and have no huge land masses, only in the interior of which can regions of the Siberian type be found.

Interior highlands. In the interior of the northern continents there are lofty mountains, the Altai and Siberian highlands in Asia and the great cordilleras of the Rockies. The windward slopes are fairly well forested, and the leeward slopes dry and bare. Rainfall is heavier on the southern slopes in Asia and on the western slopes in America. Vertical vegetation zones can be marked clearly, the forests giving place to steppe, tundra, and finally, to ice and snow. Agriculture is impossible except in the valleys, and hunting still remains the principal occupation of the people in the Altai. These highland regions are important chiefly for their minerals, which include gold ; but mining is not so well developed in the Altai as in the Rockies. The ranges act as great barriers to easy intercourse and communication, though in Canada trans-continental railways like the Canadian Pacific Railway cross the Rockies through certain passes, for example, the Crow's Nest and the Kicking Horse Pass, and establish communication between the east and the west.

Interior very high lands. The Tibetan plateau and its counterpart, the plateau of Bolivia in South America, do not belong to this zone if we consider only their latitudes. It is, however, their great height that chiefly determines their characteristics as natural regions. The high mountains of northern Tibet rise above the snow-line, and the valleys are uninhabited and barren ; and it is only in the valleys of southern Tibet that we find a sparse population. High up the mountains, we have glaciers and snow-fields as in polar highlands, while other parts, like the polar lowlands, have a meagre vegetation which furnishes food for the yak. The yak is the characteristic animal of this region ; it is a sort of hairy bull, adapted for living at great heights, and is associated as the Nandi with the Hindu God, Shiva, whose abode on Mount

Kailas is in these Tibetan highlands. Gold, silver and precious stones are found in these mountains, and barley, pulses and fruits like peaches, apricots and mulberries grow in the sheltered valleys. Bolivia resembles Tibet to a certain extent; the llama is the counterpart of the yak; the precious metals and gems are also abundant.

Eastern margins. This region includes eastern Canada in North America, Manchuria and Amuria in Asia and southern Argentina in South America. The last is still undeveloped. Manchuria, as the autonomous state of Manchukuo, with its fertile plains and valleys is now showing signs of great economic development, under the drive and influence of Japan, while Amuria with the clearing of its forests is progressing well under the eastern policy of the U.S.S.R. The winters in this region are colder than on the western margins and there is much lighter rainfall. All countries in this region are densely forested; but in Canada there has been much clearance, though its forest industries still remain very important. Lumber, floated down the Canadian rivers, is worked up at Ottawa and other centres by hydro-electric or water power into many useful articles, such as wood-pulp, paper, furniture and railway carriages. In the areas where the forests have been cleared, agriculture and dairying are important; in the cities, manufacturing industries are making rapid headway; while on the coasts, there are valuable fisheries.

Polar regions: lowlands. This region, known as the tundra, is found in the extreme north of Eurasia and North America. The cold is very intense throughout the year. Prolonged and severe winters with long nights with hardly any daylight, and short cool summers with hardly any darkness are characteristic features of these lands. For the greater part of the year the tundra is covered over with snow which melts only a little in summer. The vegetation is very stunted; mosses and lichens, some small bushes and stunted plants grow in sheltered areas near the rivers. The reindeer is the characteristic animal of the tundra; it furnishes food, clothing and means of transport to the scanty population of the Eurasian tundras; but the caribou, the counterpart of the reindeer in North America, has not yet been harnessed to the service of man.

Highlands. The climate in these regions is still more extreme, and vegetation and animal life still scarcer. Greenland is the typical region. Ice of unknown thickness, probably some thousands of feet, covers practically the whole area and makes it uninhabitable. The scanty population on the west coast eke out their subsistence by hunting walruses, seals and bears. The flesh serves them for food ; the furs and skins provide them with materials for clothing and shelter ; the fat gives them oil for lighting and heating ; and the bones and fibres are made use of in a number of ways. Antarctica, the vast and high continent girdling the South Pole, is even more extreme than Greenland and is uninhabited. It is difficult to realize the extreme rigours of climate and the privations of a hard life in such lands ; but a study of the conditions on the heights of lofty mountain ranges like the Himalayas and the Andes will serve to give some idea of the condition obtaining in the polar highlands.

CHAPTER VI

MAN AND HIS ENVIRONMENT

1. RACE

THE people inhabiting different parts of the world are by no means alike; they differ from one another in many respects. These differences are to a large extent due to the long, slow, silent, but relentless influence of geographical environment. The geographical factor in shaping men's destiny has often been overlooked, and the human factor has often been over-emphasized. It is true that modern man is no longer in that firm grip of his environment which in the case of primitive man determined his mode of life, his outlook, and even his religion. Though freed in details here and there, he is none the less bound, in essentials, to the influences of geographical control, and his work is more productive of results when the natural and human factors function in harmony, than when these are antagonistic.

Classification into races. Peoples differ from one another in their physical characteristics, in their mental characteristics, in their dress, in their language, in their religion and in many other particulars. The different physical characteristics suggest a classification of peoples into races; but it is a matter of question which of these characteristics are passed on unchanged from generation to generation and which are produced, or altered by environmental control.

Colour of the skin. A common language or religion is not necessarily an indication of racial kinship, for history furnishes us with many examples of victors imposing their language and religion on vanquished nations. English is the language of many different peoples with different physical characteristics in different parts of the world, and Islam is the accepted religion of many Negroes as well as of the Arabs, who differ so widely from them. The **colour of the skin** too, while it is useful if taken into account along with other characteristics, is not a sure indication of race. It is due to the brown pigment

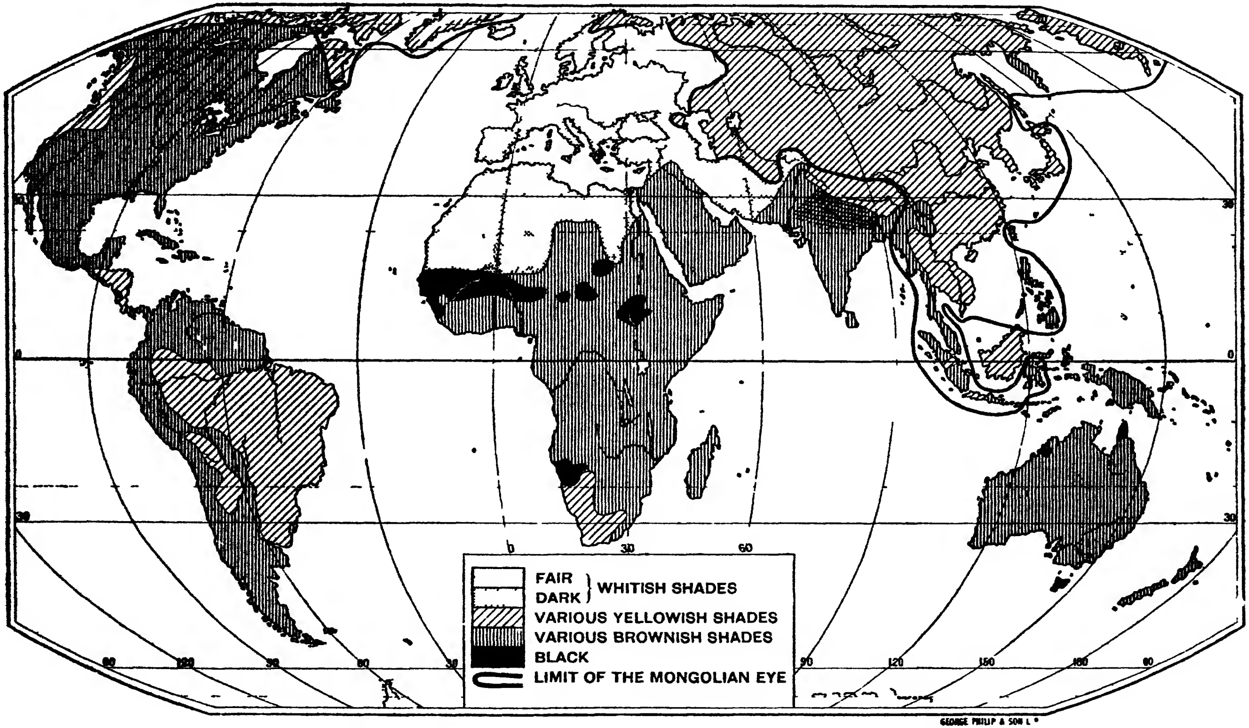

FIG 77 Races—colour of the skin

under the outer skin, which varies in amount and distribution among different peoples and therefore accounts for the variations in the colour of the skin, and for those in the colour of the hair and eyes. Exposure to the Sun causes tanning of the skin by increasing the amount of the pigment, and long residence in the tropics induces a darker tint. Thus the distribution of man by skin-coloration suggests that there is geographical or environmental control. The equatorial peoples are on the whole the darkest, and the pigment gradually diminishes to the brown people of the tropics ; the temperate zone people are fair, while the sub-tropical people are relatively dark. The progressively darker shade as we proceed from the equator polewards suggests a correlation between temperature and skin-coloration. The skin colour, once established, persists for generations; and though alterations in the pigmentation are brought about to some extent by changes in environment, such altered pigmentation and changed skin colour do not descend by heredity. It is not, therefore, known exactly what parts heredity and race, on the one hand, and environment on the other, play in the matter of skin-coloration. Whatever the true causes may be, it is usual to accept the broad classification of the peoples of the world into black, brown, yellow, red and white.

Stature. Stature is another characteristic that helps in the classification of races. While it is true that the heights of people vary, the average height of one people remains more or less the same. Environment may produce changes in the average height; unfavourable conditions may, if long-continued, reduce the average stature, and favourable surroundings may, in the long run, improve it ; so that while useful as a secondary test of race, stature cannot be accepted as a sure indication of it. Yet we do classify people of the world as tall, with an average height between 5 feet 8 inches and 5 feet 4 inches, and short, with an average height of less than 5 feet 4 inches. The dwarfs or pigmies have an average height of under 5 feet.

Other indications. Peculiarities in the shape of the eyes, jaws, cheek-bones, and nose are fairly good indications of race. These factors are useful in tracing the descent of certain intruding stocks in an area, but cannot well be applied for outlining a broad race-classification.

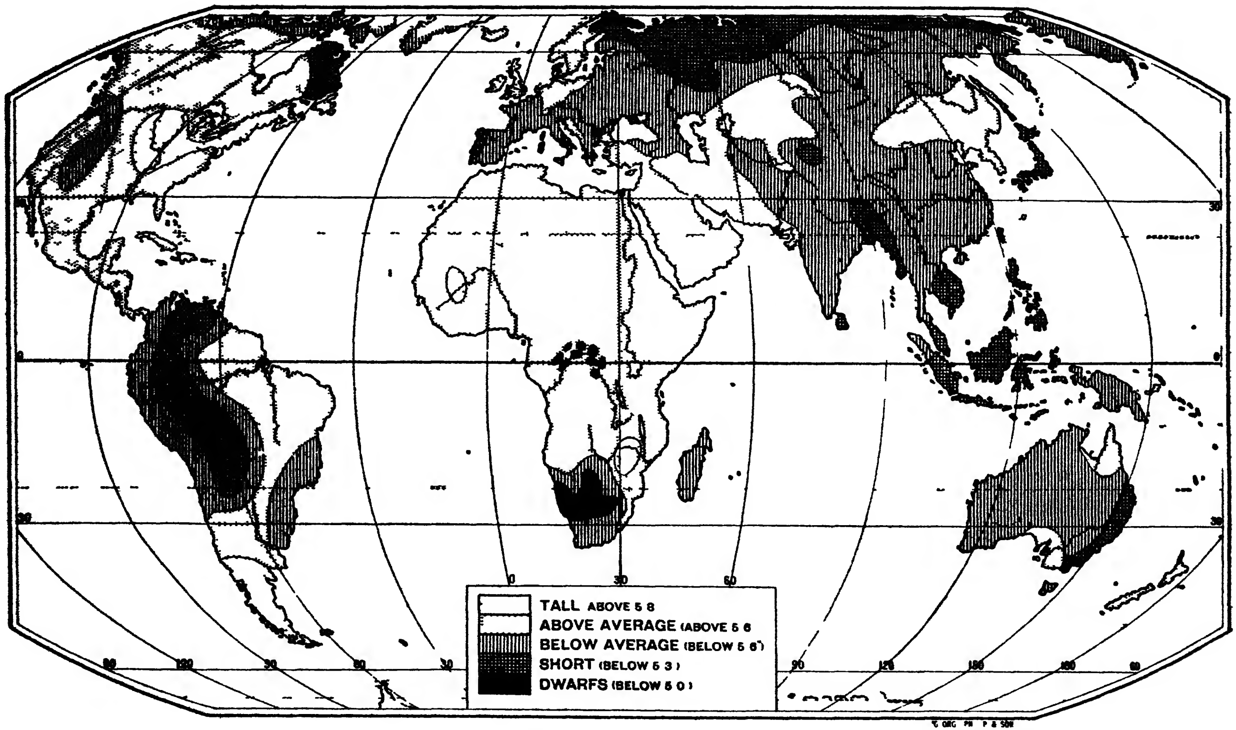

FIG 78 Races—stature

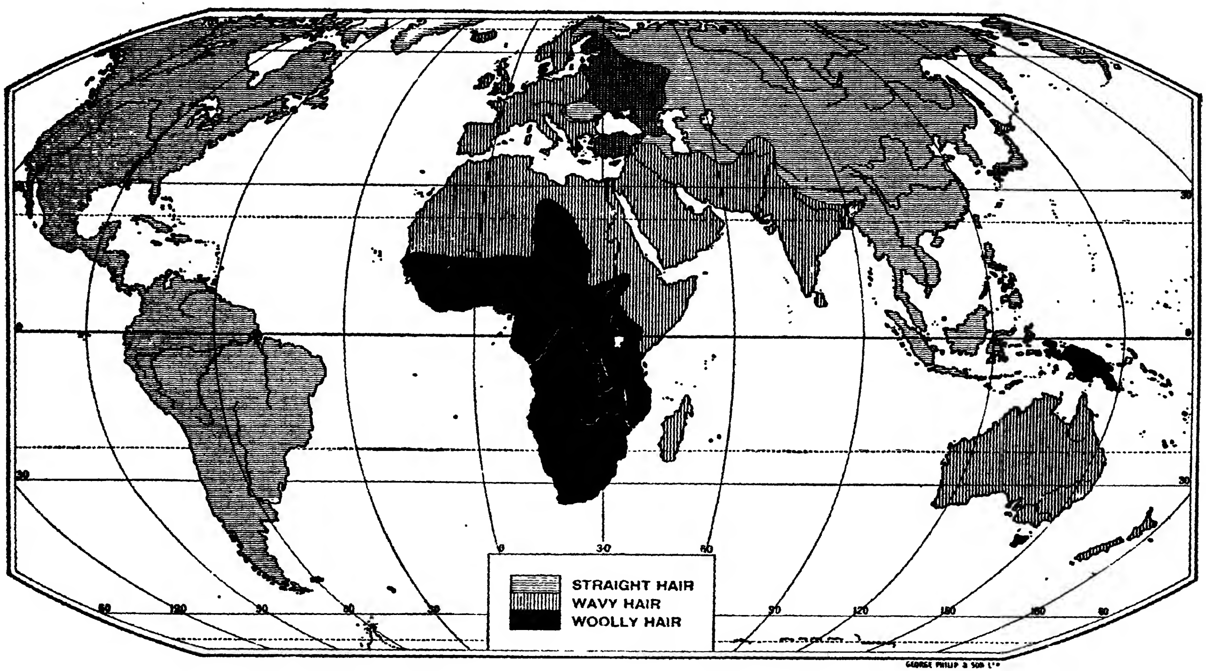

FIG. 79. Races—hair texture

The **hair,** straight, wavy, and woolly, is usually a very reliable indication of race, inasmuch as it is heredity which determines the type, and not environment, which is unable to modify it. Hair texture, therefore, gives us three broad groups. The **shape of the skull** is also a very trustworthy indication, for this also is uninfluenced by environment, and people can therefore be divided into long, medium and broad skulled.

Though hair texture, skull and facial peculiarities are better tests of race, the old colour classification cannot be entirely ignored as, after all, colour is one of the most conspicuous external characteristics.

The Ethiopian or black races. These are to be found chiefly in Africa and the inter-tropical lands bordering the Indian Ocean. The **western (African) section** of these people is to be found in Africa south of the Sahara, and in Madagascar, though it has spread over parts of the Americas by the importation of Negroes for slave-labour by the early colonists. They number about 17½ crores. Their prominent physical characteristics are a long skull, projecting jaws, broad flat nose, thick everted lips, rather prominent cheek-bones, arched brow, large round prominent black eyes, very deep brown or black skin, short black woolly hair, sparse beard, and a height above the average—from 5 feet 8 inches to 6 feet.

The **eastern (Australian) section** is found in Malaysia, Melanesia and parts of Australia, with a total number running to about 20 lakhs, chiefly in New Guinea and Melanesia. The height is about or even below the average; the hair is rather more frizzly, wavy or shaggy as in Australia, than woolly; but in the projection of the lower part of the face, the flatness of the nose and the very dark colours of the skin, these people resemble the Negroes of Africa.

The Mongolian or yellow races. These straight-haired races predominate in Asia as do the woolly-haired races in Africa. The original habitat was probably the Tibetan highland, but the peoples early spread to China, north Asia, Indo-China and Malaysia. The Mongolian peoples are now also found in Japan, Korea and Formosa, and a few have penetrated through the arid lands of Turan, Iran and Asia Minor, and to Europe as far as the Danubian plains. The

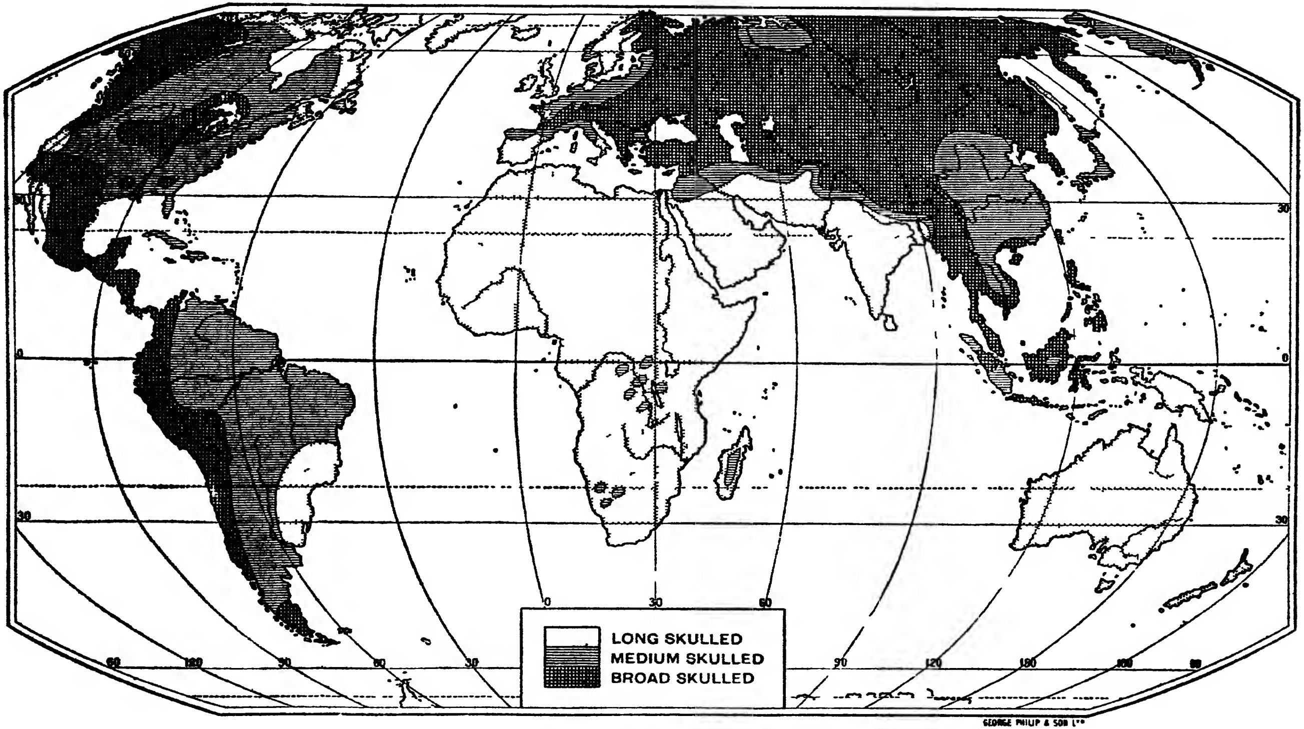

FIG 80 Races—skull form

Mongolians number probably about 55 crores of whom about 38 crores are in China, 6 in Japan and Korea, $3\frac{1}{2}$ in Indo-China, 3 in Malaysia and 1 in Manchuria and Mongolia. Their chief physical characteristics are: a broad skull, small concave nose, thin lips, prominent cheek-bones, and small oblique black eyes. The colour varies from yellowish, pale or white in Manchuria, Korea and Japan to yellowish-brown in Malaysia. The hair is long, coarse and black; there is no beard. The stature is below the average, being 5 feet 2 inches to 4 feet 6 inches.

The American or red races. If the three-fold classification by hair is accepted, these peoples, being straight-haired, fall into the class of the Mongolians. They represent probably a modification, due chiefly to environment, in the original Mongolian stock that probably crossed over to the Americas when Asia was connected in the north-east with these continents. Today the Americas are so dominated by the European immigrants and their descendants, that the various subdivisions of the red race can hardly have more than an academic or historic interest.

The Caucasian or white races. The wavy-haired peoples of Europe and south-western Asia have been generally classed together as the Caucasian race; but it is now recognized that there are three distinct races in Europe. The **Northern** race has a long skull, and is tall and fair. It is found in northern Europe, particularly in Scandinavia and Denmark. The **Alpine** race is spread over Europe, chiefly in the highland areas, but also in the plains of Russia, and is broad-skulled, less tall and less fair than the foregoing. The **Mediterranean** race, well seen in Spain and Italy, is short and dark and has a long skull. These races have intermingled in peace and in war and the people in the various countries often show a mixture of various races. The Mediterranean race has two chief branches. The **Semitic branch** inhabits the areas around the Arabian desert, and includes the Jews and the Arabs. The Persians, too, show the typical Mediterranean features, though they also show the influence of both foreign intrusions. The Semites have the wavy hair and long skulls of their race and have oval faces and fine features. The **Hamitic branch** is characterized by a darker skin, less fine features and frizzy hair, characteristics perhaps due to the intermingling of the Negro with the Semitic stock. The eastern Hamites are represented by the **fellahin** and the **Copt** of Egypt and the **Somali** near the Red Sea, while the western section includes the Tuaregs of the Sahara and Berbers of the Atlas region. The Abyssinians represent the blend due to the intermingling of the Hamites and Semites.

Races in India. The race problem of India is very complicated, for there are many different original stocks. The **Pre-Dravidian,** a short and dark race, was probably the earliest race to settle in India and has been pushed southwards by the Dravidians, so that it is now only to be found in a few isolated tribes in the south of India, though its influence has penetrated as far south-east as Australia. The **Dravidian** race is wavy-haired, long-skulled, short and brown-skinned, and is to be found in the peninsula part of India. It includes the Bhils, the Gonds, the Marathas, and the Tamil and Telugu speaking peoples, who have spread in large numbers to Ceylon and Malaya. The people of eastern India are descended from an **Indonesian** stock, wavy-haired, taller than the Dravidians, light-skinned, with modifications due to a mixture with the Dravidians and the South Mongolian elements. The **South Mongolian** race is found in the mountain country of the north and of the east. The Gurkhas and Nepalese, short, hardy people, are very similar to the Tibetans on the other side of the Himalayas. The **Aryas,** a group of the Indo-Afghan race, with great affinities to the Mediterranean race, entered India from the north-west, and after struggles with the Dravidians for mastery, so often referred to in their mythology as wars between the gods and demons, mingled with them. The Aryan characteristics are perhaps seen most purely in the Sikhs, and fade out along the course of the Ganges, so that in Bengal, the Aryan influence is not clearly marked and the earlier Dravidian type persists with little modification. The Rajputs also belong to this Aryan race, but there has been a great deal of intermingling with later invading peoples. The **Scythians** and, later on, a branch of the **Huns** overran north India. Still later waves of Mongolian races intruded into India, but these have left little impression in the matter of race.

Environmental influence. Thus races have characteristics that are independent of environment, and are transmitted by heredity. The woolly-haired Negro cannot acquire wavy or straight hair; go where he will his descendants will have the same woolly hair. The Mongolian retains and transmits his peculiar eyes, straight hair and yellowish skin whether he goes to the polar regions in Lapland and Finland, or to the equatorial regions in Malaya. Yet races do not altogether escape environmental influences. The progressively lighter skin from the equator to the poles, the yellow loess in the region of the characteristic home of the yellow race, the spread of the Alpine race in high land regions of Eurasia up to the Pamirs, the Semitic in the deserts and semi-deserts of south-western Asia, and the Hamitic along the African shores of the Mediterranean and Red seas are points which suggest some correlation between race and environment. The influence of environment may be very slow and may not show itself for centuries. The blending of an intruding race with the native population accelerates the process of change and adaptation. The Aryans and Dravidians have thus mingled and it is hard to distinguish pure strains. The European race intermingled with the original people in Central and South America and people of mixed descent predominate. The intermingling to a smaller extent of the European races of North America with the Negroes introduced for slave-labour, brings about mulattos, quadroons and octoroons, so that a fusion of races takes place, creating a blend more in harmony with the environment.

If the distribution of peoples is considered broadly, we find a close correspondence of the various racial characteristics in different regions. In the higher latitudes, we have straight hair associated with short stature, white skin and broad skulls; in the middle latitudes, we have wavy hair with medium stature, medium colour and medium skull; and in the lower latitudes, we have woolly hair with tall stature, dark colour and long skull. In the higher latitudes, on the western margins, the white skin-coloration becomes florid, on the eastern margins it becomes pale, or yellowish. Man, however, cannot be rigidly segregated and isolated in particular regions as can vegetation and even animals, and it would not be possible to divide the world into race regions correlated to climate and vegetation; for movements of people have brought about intrusions, and led to blending and intermingling, so that in course of time some racial characteristics changed, some remained unaltered and mixed races have come into existence. But that there is some correlation between heat and skin-colour, between heat and hair which from being straight, turns wavy and then curly, between heat and moisture and stature cannot indeed be denied.

The mental characteristics of races yield more readily, perhaps, than the physical traits, to geographical control, but though physical characteristics may persist unaltered for generations even in a new environment, environmental influence cannot definitely be ruled out altogether.

2. CHARACTER

While physical characteristics do not respond so very much to geographic control, the influence of environment on the character of man in different regions is prominent enough. While individuals in a region may not be affected by the influence sufficiently to rise, and might remain at a lower level, and while others may rise above the limitations and handicaps of the particular environment, there is little doubt that the main body of the people in a region has a character largely determined by the environment.

Influence of climate: temperature. The degree of effort required for man's struggle for existence determines his character to a large extent. In the **equatorial** region, nature is bountiful, vegetation is luxuriant and man therefore tends to be idle and fitful of effort. He has plenty of leisure and progress is often the result of an intelligent use of leisure; but idleness prevents this and leads to man, here, being unprogressive. Great heat makes for a passionate, sensuous and boisterous nature, and the absence of any need for close association and co-operation with fellow human beings tends to create a rather revengeful, treacherous and cruel disposition. For such characteristics, the African Negro does not deserve blame or contempt, for he is what lavish Nature has made him.

The **polar** man on the other hand suffers from the short-comings imposed by niggardly Nature. The extreme cold and the absence of vegetation make the struggle for existence very arduous, and the arctic Eskimo cannot afford to be idle like the equatorial Negro. He has to toil on unceasingly and the struggle is so hard that it leaves no leisure for the mind to develop. He thus becomes very slow like a lumbering beast, such as his polar bear; he is backward, simple and unprogressive.

In the **tropics** conditions are similar to those near the equator. Vegetation is abundant, heat and rainfall are sufficient and man is not, therefore, deficient in energy. The growth is precocious and intelligence ripens quickly. Man matures early and withers early, and is not generally long-lived. The ample leisure is turned to good use and imagination runs riot, producing bewildering complexity and succession of ideas and projects which energize him and give him enthusiasms; but, though not fitful, his energy and enthusiasm are not long sustained. He tends to be fickle, changing from the pursuit of one idea to that of another very quickly. Quick and alert, he will quickly tire. Passionate, excitable and revengeful, his animosities are but passing phases; quickly aroused, he is quick to forgive and forget; ambitious, he is yet contented; on account of lack of the sustained effort needed for the pursuit of the ambitions suggested by his acute intelligence, he falls back on contentment. Metaphysical speculations blend strangely with materialistic desires, for the non-attainment of which he seeks solace in spiritual philosophy. The Indian is typically a man of the tropics, with the characteristics mentioned above more or less developed. Many of the Europeans who come over to India for administration, business or pleasure react to the new environment and develop excitability and irritability, and experience languor and fatigue unknown to them in their own regions. Man has learned, however, to rise above his circumstances to a great extent, and tries to circumvent the handicaps of nature. The corrective efficiency of high altitudes is requisitioned periodically for the collective deficiency of low latitudes, and European nations seek to solve the problem of tropical colonization by the occupation of reserved highlands.

In the **temperate** countries, conditions are in a sense similar to those in the polar regions, but considerably modified. The struggle for existence is none too easy, but at the same time not too hard. Hard-working and industrious, dogged and determined, patient and persevering, stolid but solid, the temperate man is slowly aroused, but slow also to forget, slow to mature, but slow also to wither, slow to decide or take a side but slow also to slide away, slow to reflect but slow also to deflect ; and his grim tenacity of purpose carries him much farther in the achievement of his aims, aspirations and ambitions than the quick-witted man of the tropics. In these cooler lands hard work and thrift become habits, which lead to industry, inventiveness and increasing efficiency.

The **sub-tropical** or **warm-temperate** region is climatically intermediate in character between the tropical and cool temperate regions. The people, therefore, as seen in the case of the people of the Mediterranean region like the Italians and the Spaniards, also represent an intermediate type.

Rainfall. Rainfall is no less significant in moulding man. Where it is heavy, there are usually **forests** which do not admit of the easy intercourse and inter-communication so essential to progress and the development of man. The forest people therefore remain primitive, simple and backward, while in **grassland** regions with moderate rainfall, people tend to be more progressive and advanced. The **arid regions** of scanty rains are generally placed between desert regions and fertile valleys, and tend to develop the commercial instinct in man who plays the role of middleman, collecting and distributing the products of neighbouring lands. The ever-present danger from the desert hordes creates a class of non-aggressive, chivalrous fighting men in these lands of stock raising, who are adventurous and enterprising and are good horsemen. The trading class, because of this uncertain life, develop thrift and the habit of hoarding in small bulk with high value, so as to have the least impediment when the need for a hasty migration becomes urgent. These two types, fighter and trader, are represented by the Rajputs and the Marwaris of the arid regions of central India, and such are the Arabs and the Jews of Syria and Palestine. In the **deserts,** the conditions of life are difficult ; people have to be constantly on the move from oasis to oasis and naturally become nomadic and roving. A hard life makes them hardy, and the perils of the desert make them adventurous and brave, but at the same time simple and with but few ideas. Their whole life trains them to be vigilant, courageous and patient. The free nomadic life stimulates a sense of freedom and independence and nourishes a desire for liberty. These people are therefore not very amenable to discipline. This is not to say that they do not co-operate; they move about in groups, and this group-co-operation tends to generate the spirit of tribal loyalty and faithfulness. Hard conditions of life also lead to greater appreciation of the hardships of others, and desert peoples thus develop the qualities of hospitality to a remarkable degree. Their keen sense of loyalty and faithfulness to their own group is so strong that treachery and disloyalty provoke their wrath; so that while they do not harbour a slow lingering malice, they will swoop down to revenge wrong and insults, to which they are extremely sensitive. These qualities are best seen in the Arabs who are the typical desert people. If we make allowances for temperature differences, the Eskimo of the ice-deserts or the Mongolian is not very different from the Arab whom he resembles in hospitality and faithfulness.

Surface features: mountain regions. A hard life, isolation in valleys, and difficulties of intercourse are characteristic features of highland conditions, so that the people in these regions are sturdy, brave and liberty-loving, but often simple, backward and unprogressive, slow and stolid.

They are essentially conservative, for their environment does not spur them on to change, and outside influences do not reach them. Being conservative, they are sensitive to criticism, suspicious of strangers, superstitious, religious and strongly attached to home and family. The struggle for existence is hard, and this develops in them the qualities of frugality, providence, industriousness, honesty and indifference to luxury. Thus mountain regions, like remote islands, by isolation and retardation, often preserve old customs and practices. Mountain people have to raise their food-supplies from an unproductive soil, and under the stimulus of hunger often raid the fields and stores of their richer neighbours on the plains below. In this way, the tribesmen of the Hunza gorge supplemented their slender resources by raiding caravans on the trade route between Kashmir and Yarkand and by pillaging the Gilgit valley. The Pathan of the Suleiman and Kirthar frontier, who regularly looted the plains of Sind, had his counterpart in the cattle-lifting clans of the Scottish Highlands, and the forest Bhils of the Vindhya and Satpura ranges indulge in their old-time habits of cattle-lifting in times of drought. Among mountain people, as among desert people, robbery tends to become a virtue, a clear response to the environment, which, after all, dictates the ethical code of the people affected.

The barriers of the mountain walls isolate mountain people so effectively that they do not find it easy to co-operate and take concerted action and to submit to outside authority. The restrictive environment lends itself characteristically to the formation of clans and tribes and the establishment of a feudal and republican type of government on a small scale, the central authority if any, being weak. Great isolation and protected location tend to produce an over-developed individualism, social and economic retardation and small and loose organization of the social structure. Thus the diversified relief of ancient Greece led to the formation of the small city states, which maintained their political individuality and aloofness, except under pressure of the menace of foreign aggression. Even modern Greece is a collection of separate districts, and the influence of the restrictive environment is seen in the retardation of the evolution of a national spirit.

In mountain regions we often meet with powerful and turbulent chiefs and sirdars of feudal clans. The mountain dweller is faithful to his hereditary chieftain and clings to a long-established order, so that feudal rule appeals to his conservative instincts. The rugged and broken relief of Switzerland has given to it the typical form of government that is naturally well suited to such environment. The commune and canton are the real centres of government ; the federal power at Berne does not greatly concern the Swiss peasant. A very similar system is found among the tribesmen of the Atlas mountains who have in the **jemma** the counterpart of the Alpine commune. Throughout the vicissitudes of fortunes, which brought the tribesmen in towns under the control of the Romans, Arabs, Turks and French, the **jemma** enjoyed complete local autonomy, their administration being carried on by an assembly of all the adult male inhabitants. The size of such communes becomes smaller as the region becomes more inaccessible as is seen in the case of the high north-western Himalayan ranges. In the Shinaka district, each valley is a small canton and each village is a commune; the assembly composed of representatives from each village decides questions of general policy, by the vote of its members.

The small size of the administrative units is sometimes found associated with monarchy which frequently degenerates into despotism. The Tibeto-Burmans of the eastern Himalayas have an organization which allows very little authority to the ruler of a group of villages. The Khasi hills of Assam are divided into quite a number of petty states each under its own Rajah, who, however, enjoys but little power. The disfavour with which centralized authority is viewed is thus a characteristic trait of mountain dwellers everywhere. On the north-western frontier of India, the Pathan and the Baluch recognize only the authority of the **jirgahs** or assemblies of the clans. The lack of a national spirit and the presence of clan-sectarianism is in evidence in almost all mountain regions.

Combination in mountain regions must therefore be such as entails the minimum of submission. Such combinations are best found in the confederation, which may in course of time become stable and elaborate if the people are advanced enough, as in the case of Switzerland. Medieval Scotland had a monarchy; but the king, a sort of an overlord over feudal barons, had but little real authority. The Maratha confederacy in the highlands of central and southern India similarly had a weak king, while the real government was in the hands of the most powerful of the sirdars, the peshwa. Japan developed in the same way the system of the shogunate, so that while the semi-divine mikado reigned at Kyoto, the most powerful of the barons ruled as the shogun at Tokyo. Nepal has, even now, a very similar system, the king having but little real power, while the work of government is carried on by the prime minister who is the leader of the most powerful clan. The Negus of Abyssinia derived his power from the co-operation of his feudal chieftains, and the Afghan King is under the control of his powerful tribal chiefs, whose conservatism revolted against the reforming zeal of Amanullah and led to his dethronement. Afghanistan has countless clans and tribes separated by natural barriers and by the intrusions of foreign stocks. The tribes have achieved a cultural, religious and linguistic unity, but diversity of political aims does not give promise of any national unity.

In modern times, however, the development of means of communication and transport is fast robbing the highlands of their isolation, and is stimulating intercourse, with the result that the peculiarities in the character of mountain people are no longer so prominent as they were in the past.

Plains. In plains, the characteristic feature is easy communication and intercourse, leading to development of the intellect and the evolution of civilization and progress. The struggle for existence is not so hard as in mountain regions, and there is no need for the group or tribal structure of society, which is thus largely individualistic. Easy life brings about a desire for ease and pleasure and peace ; but the development of the intellect breeds cunning or shrewdness and ambitions. The people of the plains therefore tend to become politically-minded and intriguing. They have a great diversity of occupations, commercial and industrial ; they are amenable to discipline as no mountain or desert peoples are ; but they are not martial. And yet, in a conflict between the mountain peoples and those on the lowlands, the superior intellect and organization of the latter have made them victorious, though for individual bravery the highlanders have none to excel them.

In the plains, there are resources which the mountains do not possess, and the raiding incursions of mountain peoples end in the subjugation of the lowlands ; or, as has happened frequently, the marauders provoke the spirit of reprisal among the people of the plains and are conquered and embodied in the lowland state. Nepal, after the conquest of the petty states in the neighbourhood by the Gurkhas in the latter half of the eighteenth century, commenced a series of raids, depredations and encroachments upon the Indian **terai,** the fertile alluvial lowlands of the foothills of the Himalayas, and by 1860 had annexed a large part of it, so that the little highland kingdom strengthened its geographical and economic bases. More often, however, the slender resources, sparse population and lack of centralization on the mountain regions lead to subjugation by the stronger and better organized states of the plains. The authority of the Russian plains thus spread over the Caucasus region, and Kashmir tried to conquer the predatory hordes on its north-west. India similarly extended its authority over the Gilgit and Hunza valleys, like the Chitral to the west, which are highways through the mountains and are therefore strategically very important. The conquest of mountain-peoples, however, is not easy; it involves a long-drawn-out struggle and great expenditure for the invaders, to face the rigours of nature and the great intrepidity and courage of the bold defenders of their homes. 'A small army is annihilated, a large army starves to death.' The spirit of independence of the mountaineer, his skill in mountain strategy, his gallant resistance, and his refusal to accept defeat always lend a touch of heroism to mountain warfare, though ultimately the highlanders succumb to numbers and the superior organization of the lowlanders. Thus, in the early struggles between England and Scotland, the victory ultimately lay with England; and in the conflict with the Great Moguls, the heroism of the gallant Rana Pratap and other Rajput rajahs of the central Indian plateau was overcome by the superior generalship and superior organization of the hordes of the plains. Switzerland was in the same way dominated by the Austrians for a long time, and Bavaria accepted the leadership of Prussia.

The tendency to bring about homogeneity, fusion and blending of all elements pouring into them is characteristic of plains. It is this tendency that has enabled the United States to absorb the heterogeneous inflow of immigrants from all parts of the world. Here the English, the Irish and the German met and mingled with the Chinese and the Japanese from the Far East and the Negroes of Africa; the Mississippi plains set in motion the forces of unification, so that different nationalities have blended into one great American nation.

Plains usually have a fertile soil and they are therefore the great agricultural regions of the world. The flatness of the land facilitates intercourse, leads to an exchange of ideas, develops commerce, and furthers the activities characteristic of modern civilization. It has been, however, small and protected plains, rather than wide expanses, that have seen the rapid achievements of human progress. Whether the small plain be a part of a large land mass or an island it inculcates in the people a sense of homogeneity, makes them realize the need for co-operation, and thus fosters the evolution of a national sentiment. The north Atlantic coastal plain and the British plain are good examples. The large extensive plain has not had the same influence. It gives a restless urge to movement. Wider and expanding horizons and cheap lands induce the dweller in wide plains to spread out, and prevent him from concentrating on his own lands. Thus the central Asiatic people spread eastwards and became the terror of China; they flung themselves southwards and descended upon the plains of India; they marched westwards, and became a scourge to the settled communities of eastern Europe.

Coastal plains. On **coastal plains** a similar character develops, and if the coast-line is broken and easily accessible from the interior, as in the case of the Gujarat and Malabar coasts, intercourse and trade with foreign countries by sea are facilitated, and the people not only become progressive, civilized, though ease- and peace-loving, but develop a broad cosmopolitan outlook instead of becoming sectarian or communal, while the nearness of the sea makes them adventurous and enterprising with a well-developed commercial instinct. If, however, the coastal lands are not easily accessible from the interior, as in the case of the Konkan, the people tend not to be intelligent, progressive and ease-loving, but, being isolated, are simple and backward, though adventurous, and make good fisherfolk and seamen.

Islands. Islands are peculiar regions and will stimulate special characteristics among the people inhabiting them. Insular peoples, by constant association with the sea, are often seafaring, adventurous and enterprising; but their insularity brings about isolation to a greater or less extent and breeds a spirit of independence, a love of liberty associated with reserve and conservatism. Small oceanic islands, such as those in the Pacific, do not therefore permit any great progress or intellectual development, while small continental islands produce a type hardly distinguishable from the type of men on the mainland, except in their comparative simplicity, backwardness and conservatism. Very large islands like Australia are not one homogeneous region and produce diverse types in harmony with the varied environments. The islands comprising New Zealand produced a progressive people, the Maoris, superior to many island peoples in the Pacific, but insularity and consequent isolation cut off the people from ready contact with other areas. Islands like the British Isles and Japan offer, however, a type of region capable of very great development, based on their insularity on the one hand, and their facilities for intercourse with neighbours on the mainland, on the other.

The **situation** of an area relative to the larger mass of a region often exercises a significant influence. On a **land frontier**, the people, by force of circumstances, have to develop a turbulent and martial spirit and may develop a defensive or an aggressive spirit, according as their own region is better or worse than that across the border. They are thus brave and courageous by the elimination of the weaklings and are in the front in attack or defence. The Pathans on the north-west frontier of India are restless, courageous and recklessly brave, while the Punjabi is a brave defender of the homeland, though peacefully inclined as he lives some little distance from the actual frontier and the main line of Indian defence—the Indus. On frontiers, 'frontier incidents' are naturally common, and furnish occasion or excuse for wars between neighbouring lands, particularly when these lands have irreconcilable and antagonistic aims and policies. The political frontier changes, and the frontier character, though it persists for a long time, gradually fades out in the old region, and the new occupants develop the qualities which circumstances force upon them. This is seen very well in India, where the frontiers between the various states in the pre-British period no longer exist and no longer influence the character of the people in those regions.

Interior lands are relatively peace-loving and unprogressive through lack of intercourse with people of foreign lands; but central situations, being suitable for distribution and administration, will develop a broader and more cosmopolitan outlook than mountain regions, a tendency in the direction of home trade and the art of government.

It must be noted however that the different features of environment do not produce their influence separately. The temperature conditions, rainfall, surface features and situation must all be considered together if we are to understand the character of the different people in the world. Regions which may be alike in some particulars may be dissimilar in other respects; and as the character of the people is the result of an intermingling of many influences it will present a composite picture often difficult to analyse. Thus, monsoon jungles and Siberian coniferous belt can hardly be expected to develop the same characteristics. The Deccan plateau and the Spanish meseta, Gujarat and Chile, the Ganges and the Nile, the Sahara and Mongolia are other illustrations of the same point. Besides, in modern times more than ever before, the great development in means of inter-communication and intercourse makes it impossible to segregate human types in particular areas exposed only to particular environments. The desert Arab mixes with the French or the German of the great European plain ; the tropical Indian spends some of his time in temperate England and the Englishman in tropical India and Africa ; and the distinctions between different peoples of the world are decreasing in intensity with the levelling touch of increased and easy intercourse.

3. CLOTHING

Dress, no less than physical and mental characteristics, is to a very great extent, controlled by geographical conditions in the different regions. Nudity is ordinarily associated with a low plane of civilization ; nude people are held to be generally more or less savages. On the other hand, a closely wrapped up figure, with skins or padded garments and coverings, with the face only exposed or with bare holes for the eyes and the nose looks like an animal. The nude is often looked upon as an excitable being, while the closely wrapped up person as a slow-witted, dull lumbering creature.

It is obvious, however, that neither nudity nor close and thick wraps depend so much upon the whim and fancy of the individual as upon the requirements of the climate of the region in which he lives. Covering, in the case of animals, corresponds closely to their habitat, whilst, as regards human beings, if an artificial covering were not provided in the shape of clothes, the human body would develop a covering, in the shape of hair, answering to climatic requirements.

That clothing is correlated to climate is apparent when we trace in a general way its amount and kind from the equator to the pole. The great heat, the torrential downpour of rain throughout the year, the dense vegetation of the winterless equatorial selvas render clothing almost unnecessary during day-time and reduce it to a loose wrap for the night for protection against the chilling effects of a falling temperature. It is not because he is still uncivilized that the African wears so few clothes. The climate of equatorial Africa compels him to dress scantily ; and since this climate is also a handicap to mental development of a high order, the low plane of civilization and the absence of clothes are both the results of the same great cause, his geographical environment. The Eskimo perpetually faces the terrors of the Arctic and the rigours of the polar cold, and lives in the ice-deserts and barren wastes of the tundras. No wonder he is muffled up in furs and skins, and does not, for indeed he cannot afford to, expose any part of his body. Take the Negro to the tundras and the Eskimo to the selvas and the former would be closely muffled, the latter almost nude.

Between the equatorial and the polar regions, there are, however, intermediate climatic belts with decreasing heat in summer and increasing cold in winter. The tropical zone is but a stage removed from the equatorial, and man there learns to cover himself in varying degree. In India, for example, the great heat of summer and the closeness of the monsoon period render it necessary to have merely light and loose garments. Man may create fashions and style, but it is nature after all, and the geographical background that determine the general nature and type of the clothes he must wear. A **dhoti** and an **uparna,** a nether and an upper covering, loose and light, preferably white in colour so as to reflect as fully as possible the solar rays, is the natural dress of the Indian, particularly in the tropical south and the hot east. A third piece of cloth wrapped round the head to ward off possible sunstroke, completes his dress. Fashion may add a border to the dhoti and create different styles of wearing it ; the **uparna** may change similarly into a loose **peheran** or a loose

badan, a sort of a short coat; the head-gear may be transformed into the stylish **phenta** of the Rajput prince, into the flaming red **pagri** of the common people or into the small white cotton cap of the Benaresi **bhaiyya.** But whatever the shape or style, the dress essentially remains a three-piece dress, loose and light. The garments are generally made of cotton; not because cotton is cheaper or because it grows locally, but because it is the characteristic clothing material for the tropical and sub-tropical zones, where man desires not so much to retain warmth, as to permit partial radiation and promote cooling. Wool is out of place under such conditions. In the parts of India, as in the north, however, where the winters are fairly cold, padded cotton garments are in use. Nature also responds to the call, and sheep in those parts yield better wool, which takes the place of cotton for clothing. Indeed the tropical conditions end there, and sub-tropical conditions prevail. Silk is light enough for the tropics and it forms the material for the ceremonial dress of the Hindus—the **pitambers** and **saris.** Another fact about a tropical country like India that needs to be remembered is the luxuriant vegetation and the flora with varied hues. This leads to a preference for printed fabrics, and variegated patterns in bright colours, particularly in the dress of the womenfolk. The sombre black or dull grey are more in consonance with the foggy and cloudy skies of the cool temperate West than with the brilliance of the sunny tropical and sub-tropical East.

Man, however, is in this, more perhaps than in other matters, not the slave of his surroundings; he ignores their dictates, and introduces fashions sometimes at variance with the natural dress, in style and in material. Thus tropical India has learnt, by contact with the people of cool temperate Europe, to adopt the European style and substitute that complex dress for their own natural three-piece dress. Cotton has given place to wool, white to black and dark blue, flowered patterns and bright colours to uniform plain fabric, the pagri to the stylish felt or the helmet, and the **chapals** to the shoes. The English people in the tropics have, on the contrary, learnt to live more in harmony with their new surroundings, and shorts and open-neck shirts are becoming more common.

Cotton and silk are replacing wool; the material for the frocks of the ladies shows a rich pattern of bright flowers; and the gorgeous golden cloth, the **kin-khab**, too, is often appreciated; socks and stockings are often left off for evening walks; gloves are being discarded. The loose-flowing robe of the Arab, his queer head-kerchief with the warm head-band, the baggy trousers of the Sindhi, Balooch and Pathan, the voluminous skirt of the Marwari woman, and in a way the Roman toga, are all in harmony with the extremes of heat experienced in their lands. The scarcity of sheep, the lack of wool and the consequent use of padded cotton garments by the northern Chinese, and the kimonos and the gaily coloured patterns of the dress of the Japanese women harmonize with their environments. The Mohammedan ladies' use of the pyjama satisfies the need for rapid and quick movements necessary in desert and semi-desert regions where Islam has chiefly spread, while the low-reaching gowns and full-sleeved blouses of the Victorian age more adequately meet the requirements of the climate than their modern abbreviations. Dress, at the equator or the pole, in the East or the West, in the savannas or the steppes, is thus largely dictated by the geographical environment; and though association with persons from other climes may introduce fashions not consistent with it, the basic dress, in material, quantity and style, is bound to remain true to what it prescribes.

4. ARCHITECTURE

Buildings for the use of man, no less than clothing, are subject to geographical control. The materials used, the style and form, the ornamentation are all influenced by the natural conditions of the different lands, and distinctive architecture characterizes different peoples and regions. That the Eskimo should live in his **igloo** or ice-hut and the Negro in his round mud hut with thatched roof is but a clear response to environmental influences. In the clayey soils of India as in Bengal, and on coastal lands as in the Cuttack and Gujarat coasts, brick buildings are common, while in areas where building stone is available, stone is the chief material used. Thus, sandstone and other building stone is the characteristic material for buildings in the Delhi-Jaipur-Agra region as in Mesopotamia and Persia, while granite is common in south India. It was the accessibility of a store of marble of great beauty that gave a stimulus to the taste for architecture of the Great Moguls, the chaste white variety having been used for the Taj Mahal. In the Nile valley the clay of the delta region leads to the use of bricks; the sandstone and limestone found some distance to the south are used for temples and important buildings; and higher up the Nile we have the characteristic granite architecture. In Japan the use of bamboo and paper as house building material is also natural. Forested lands show a greater use of timber, and the gabled houses in the well-wooded England of Elizabethan times furnish a good illustration of this. The greater strength of iron and the developments of the iron and steel industry have led to the displacement of timber by iron and steel in the construction of recent buildings.

Tropical countries do not so much want light as the free movement of air, while colder countries want more light and means to keep the colder air outside. There is therefore greater use of glass for doors and windows in the temperate lands, particularly in regions like Venice where sand for glass-making is available, while the warmer lands have verandas, courtyards, balconies and terraces, **jallis** and **chhajas** and perforated screens to keep out the strong glare of the Sun and to permit the outside breezes to cool the interior. In colder climates, squatting is not possible, and raised seats, chairs, etc. become necessary; in warmer lands there is no harm in squatting, and the position gives greater comfort and relaxation. This leads to high windows in countries like England, and very low ones, jutting out beyond the walls, in India. English houses similarly have to be provided with heating arrangements and chimneys to take off the smoke and gases arising therefrom, while India, in hot regions like Sind, needs **wind scoops** to catch and lead the outside air into the inner rooms and keep them cool. The great heat makes it further necessary to have high ceilings in rooms to interpose a long column of air and thus to prevent excessive heating of the lower air in the buildings. The construction of domes and cupolas and the tapering **gopurams** in temples is thus a response to the climatic conditions, and not merely an ornamentation device. The great cooling sensation experienced in the temples and great mausoleums like the Taj Mahal, may be partly psychological, but is certainly also due to architectural adjustment to climate. Ventilation through doors, windows and ventilators in walls, has also a place of considerable importance in architecture; and in this connexion, a study by the architect of the prevailing wind systems becomes essential, so that arrangements can

[By courtesy of Mr Ashok H Kaji

FIG 81 Wind scoops

be made to receive the cooling breezes and to shut out the biting, chilling winds. Thus in western India a house frontage on the east is much prized, for while permitting east to west ventilation, it enables the health-giving rays of the morning Sun to reach the interior; a western front is only second to this. A southern front is fairly good since it permits the south-westerly monsoon wind to enter, while a northern frontage is considered least desirable.

Rainfall, too, has to be considered in the construction of buildings. Heavy rainfall must be met by efficient drainage, so that sloping roofs are characteristic of western and southern India. But in areas of scanty rainfall and in arid regions like Rajputana, flat roofs and terraces better suit the conditions, not only by permitting the residents to escape from the heat inside to the cooler house-tops, but also by enabling the rain water to be led off by pipes and stored in tanks so as to provide good water for drinking purposes. High plinths have to be provided when there is danger of river floods. Space limitations promote a vertical provision for housing accommodation, and in New York, there are accordingly ' sky-scrapers ', in some cases even more than a hundred storeys high; in Bombay too, the sky-scraper type of architecture has in recent years found favour ; but Madras is becoming a city of distances and houses of more than one or two storeys are uncommon.

Ornamentation, carving and the artistic arrangements of the building do not escape the influences of environment. In a land like India with brightly coloured flowers and luxuriant vegetation, floral and ornate designs predominate, whereas simplicity marks the architecture of colder regions. The greatly increased intercourse between the peoples of the world, one result of increased trade and modes of rapid communication and transport, no longer allows segregated types of buildings and architecture, so that a blending of styles take place. This fusion is more noticeable in large cities like Bombay and Calcutta, where buildings of brick and stone, of concrete and iron, built in the Hindu and the Mohammedan, the Gothic and other styles can all be seen.

Historical causes, too, sometimes lead to a blending of types ; and in India the lattice work on verandas, the perforated screens, and the barred windows were commonly provided to yield protection and privacy from the prying eyes of invaders.

5. OCCUPATIONS

The occupations of man are many, and if we consider the occupations of individuals in any region, we shall find a bewildering variety. Among the people in every well-developed community we find the farmer and the shepherd ; the hunter and the fisherman ; the doctor and the lawyer ; the engineer and the builder; the painter and the poet; the merchant and the manufacturer; the carrier and the miner; the administrator and the clerk; the priest and the teacher; the soldier and a host of others following diverse occupations. But when viewed broadly, countries and regions have a number of occupations of a certain type which predominate over others strikingly enough to make us regard that type as the chief occupation of the people there; and it is in this respect that we notice a marked correlation between environment and human occupations.

Climate and vegetation. In the **equatorial and monsoon forests,** man perforce leads the life of the huntsman, supplementing his food with fish from the rivers and with wild berries and roots. Only the backward peoples depend largely on such **gathering of vegetable food** and on hunting and fishing, such as those in the Amazon valley, the Congo forest zones, the Fijians, the bushmen and the Australian aborigines. Such people obtain a very poor living; their manner of life admits of no advance in civilization and they remain in a primitive state. The women carry on a small amount of primitive agriculture in clearings in the equatorial forests and their margins. In the Amazon valley, tubers and roots give a rich return for slight trouble; in Africa, bananas, millet and other cereals; in the East Indies, bananas, yams and sweet potatoes, sago palm and rice; in the Pacific islands the coco-nut palm.

In the **tropical grasslands, mixed farming** is the main occupation. Being between the backward peoples of the equatorial forest on the one hand and the nomadic peoples of the desert on the other, the savanna populations have little incentive to progress and development. The productivity of the region does not call for sustained effort and breeds indolence in the savanna man; but greater intelligence brings within his reach possibilities of advancement. In the most typical savanna region, tropical Africa, the occupations are agricultural and pastoral. **Cattle-breeding** assumes importance on the rich pastures of the region, for it supplements and assists agriculture. The Deccan represents a savanna region where agriculture has attained importance, since the soil is peculiarly fertile, and the ancient civilization has left its impress upon the people.

The savanna merges into the **tropical desert.** It is relieved from its extreme dryness by fertile oases. Life in the desert is more or less nomadic, but a settled population is found in the different oases. **Agriculture,** more or less primitive, is engaged in, the soil being very fertile, since the soluble salts, which form plant food, have not been washed away by rain. The development of commercial intercourse has given greater importance to many oases by the passage through them of caravans from one country to another. Thus, **commerce** also tends to be one of the main occupations of the peoples of the oases. It is possible in South Africa to have ostriches, and **ostrich-farming** is therefore also an occupation of some importance in the Kalahari region.

The desert passes into the **temperate grasslands,** the steppelands. Hunting is not suitable in the grasslands and the environment there leads man to domesticate herbivorous animals. The people are largely nomadic and make their living by **stock-raising,** the scantier pastures leading them to rear more sheep and goats than other animals, except in well-watered areas where the conditions are more like those in the savannas. **Pastoral pursuits** supplemented by agriculture are thus the mainstay of steppe-dwellers ; but, in the prairies of America, **agriculture** has been developed by settlers from advanced countries. These grasslands are the great world-suppliers of wheat and meat, wool and hides and dairy products.

On the western margins in these latitudes, we have the **Mediterranean regions,** where the natural occupation of the people is agriculture, with special attention to **fruit-culture.** Wine-making is a prominent industry and the conditions are suitable for the higher development of civilization. In the **temperate forest region,** conditions of life are not easy ; the hard struggle for existence furnishes, to the more capable, the necessary stimulus, and at present there are but few forest areas in the temperate zone which are peopled by the simple forest-dwellers. In the forested north-west of North America, however, there are still fairly extensive areas covered with forests ; but **hunting, trapping** and **fishing,** which are the natural occupations of the people in these regions, have given place to **lumbering** under the influence of modern civilization and the demands of the great eastern cities. But large tracts of the temperate forest region of the world have been de-forested and cleared, so that large scale **agriculture** is now the occupation of the majority of the people. In the great central European plain, we find forest patches here and there only, and the former haunts of the bear, wolf, fox and beaver are now transformed into productive fields, yielding useful crops. The face of England has in this way been completely changed. It is in these regions, therefore, that we find the greatest variety of occupations and a complex and advanced stage of the development of the people.

The **cold-deserts** have a very distinctive reaction on the people inhabiting them. The population is sparse, and intercourse with the centres of civilization is very difficult. **Fishing, primitive agriculture** in the short summer, and the **tending of the reindeer** are the only occupations possible and they make a nomadic existence necessary. The simple and primitive people have a hard struggle for existence and have but little leisure for intellectual development.

Surface features. While climate and vegetation definitely have a determining influence on man's occupations, surface features are not less important. **Lowlands** make **agriculture** and **cattle-rearing** possible, while **highlands** reduce agriculture to rather primitive forms and encourage **sheep-rearing,** for sheep thrive well on the scanty highland pastures. Mineral deposits, especially metallic ores, were formed deep below the surface of the Earth, and are therefore to be expected in the older rock-formations ; and **mining** is consequently an important occupation of the people in regions where the old archaean rocks have been up-folded and exposed by denudation. Geological factors thus determine the location of mining industries in a particular region ; but the development and exploitation of the mineral resources depend largely upon human factors. The human material may not be responsive to environment ; transport may be absent or primitive ; instability and weakness of government may check the flow of capital to mining enterprises. China and the Balkan peninsula afford striking illustrations of the retardation brought about by the operation of human factors.

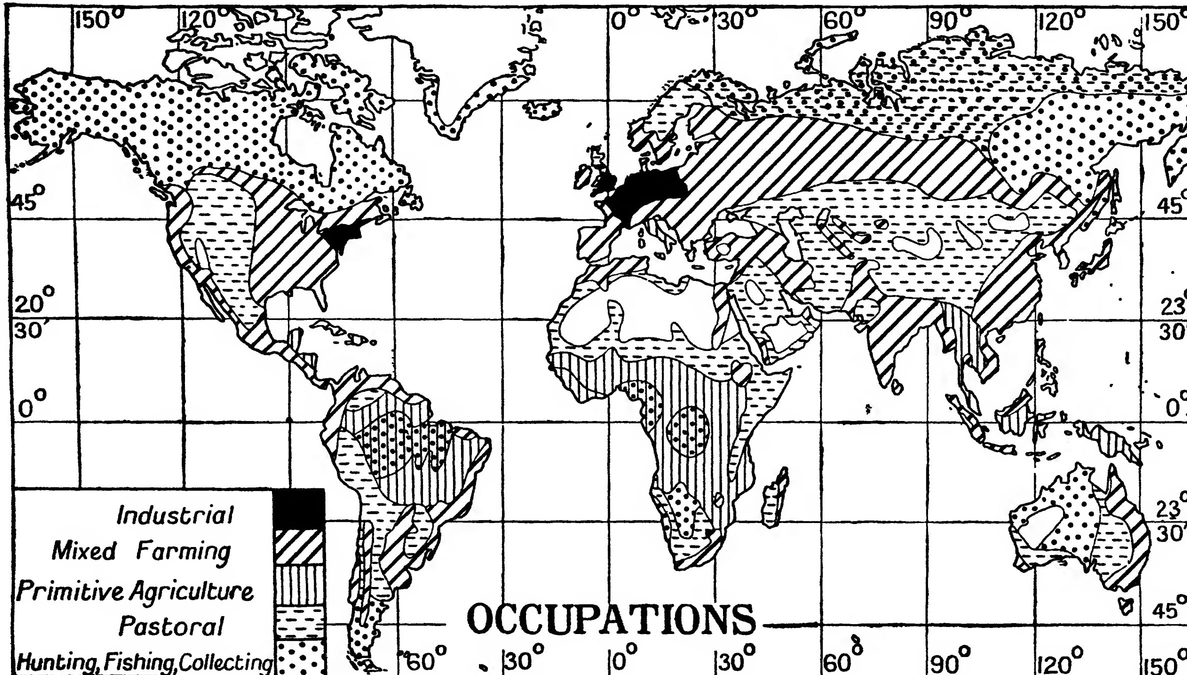

Fig. 82. Occupations of man

Situation. The situation of a region relative to land and sea masses has also a determining influence on man's activities and occupations. **Coastal lands** naturally lead to the development of **fishing** as an important occupation of all people, primitive and advanced. Fishing as an occupation very often develops off the 'drowned' coasts, where the submarine platforms form valuable fishing grounds and where the inlets and creeks afford safe shelter and convenient harbours. Few people, except the Eskimo, depend only on fishing; the gathering of vegetable produce, hunting, agriculture—primitive or advanced—are also carried on to supplement fishing. Seafaring habits breed a race of seamen, encourage a spirit of adventure and stimulate the desire for discovery and exploration. Coastal lands also tend to encourage **trading.** In advanced countries fishing has been organized into an industry. The fishers go out to fishing grounds often at a great distance from the shore; the fish are brought back in steam trawlers, and railways carry them to great cities—the centres of consumption. But, for distant markets, fish are cleaned, dried, salted, smoked or tinned and thus preserved. Fishing is an important industry in Newfoundland, the eastern Canadian provinces, and the north-eastern states of the United States, in connexion with the fisheries off the Grand Banks of Newfoundland; in East Anglia, in England, north-east France, the Netherlands, Denmark and Norway, in connexion with the Dogger Bank fisheries; and in south-western Japan, for the fisheries in the Sea of Japan.

We have so far seen how the principal occupations of mankind are determined or influenced largely by the geographical features of the various regions; but we have not considered **manufacture** which forms the chief occupation of the people in very many European countries, and elsewhere. Manufacture is, in a sense, not a separate distinctive independent occupation; for it utilizes the raw materials produced by peoples of various occupations and, by processing work and advanced methods, shapes and moulds them for various uses by man. Thus agriculture yields wheat which forms the base of the biscuit-manufacturing industry; cotton is spun and woven for the manufacture of cloth; seeds yield oil and lead to the production of soap and various other things. Sheep-rearing provides wool, and sericulture silk, for the great textile industries based upon wool and silk. The mining of coal and iron leads to the iron and steel industries, and forests to lumbering, furniture-making and similar industries. On cattle-rearing are based the dairying and meat-packing industries ; associated with fish, we have fish-curing, salting, tinning and so forth. Manufacturing industries, representing the preparation in diverse forms of the raw materials, produced by different occupations, for various uses by man, can therefore be an occupation of the people in the region where the raw materials are produced. The processes and organization are, however, so complex that manufactures become the specialized occupation of a civilized and advanced people such as the Europeans, the Americans, the Japanese and the Indians. The geographical and other conditions on which manufactures depend will be discussed later ; but, in general, it may be observed that manufacturing industries tend to be developed as important occupations of peoples in densely populated temperate and sub-tropical plains rich in iron and coal, where advanced agriculture is the principal occupation.

6. RELIGION

Many of the masterpieces of literature reflect very clearly the influences of the natural environment upon the author. The great poet, the brilliant novelist, the skilled essayist or the gifted dramatist is necessarily a person of great imagination and deep feeling, and as such is more responsive to environmental influences than ordinary people. There are few phenomena that give greater stimulus to literary effort than the grandeur of the sea, the majesty of the mountain, the grace of the river, the peace and charm of the countryside, or the hum and turmoil in busy centres of commerce and industry. One cannot separate the glory of Tagore's poetry from the beauties of the lower Ganges basin, the melodies and devotional songs of the great Maharashtriyan saint, Tukaram, from the conditions of life obtaining on the Deccan plateau, the sparkle in the poetry of Premanand and the lays of Samal Bhat of Gujarat from the intellectual and commercial atmosphere of the Gujarat coastal plain. One cannot separate the charm of Sir Walter Scott from the southern highlands of Scotland or the beauties of the poetry of Wordsworth from the enchantment of the Lake District of England.

Men's modes of thought are not less influenced by the geographical factor, even when we take it in relation to religious belief. Every race has evolved some religion or other; indeed, it is almost impossible to find a race which is altogether devoid of religion. It is true that religious beliefs are moulded by the operation of many factors; but one of the basic and most important is geographical environment. This factor may be, in some cases, very conspicuous; in others, only just perceptible; but its presence can always be traced. Indeed, there must be some correspondence between the life and thought, the economic needs, and the environment, before any system of religion can gain acceptance as a creed.

Among the very lowest of such beliefs and practices is the **fetishism** of the negro tribes of Africa, consisting of a crude worship of inanimate objects believed to be inhabited by special spirits. Higher religions are based on thought and observation of natural phenomena and man's struggle to find an explanation of the mysteries of nature and of life.

Early man had not the slightest idea why the wind blew or the cold increased as winter came; why the sun rose and set; why the thunder burst, lightning flashed and rain poured from the canopy of the sky; all such wonders constituted mysteries, which he tried to solve and explain by inventing fanciful tales of gods. It is the need of finding causes for effects that has led man to invent a deity; what he cannot understand is explained as the work of a particular god. In such a system of gods, invented to account for different phenomena, the particular environment is bound to exert a prominent influence. Thus, the ocean would not be expected to figure in the mythology of the tribes of the interior of Asia or of Africa; but it did play an important part in the mythologies of India and the Mediterranean countries. The beautiful myth of **Samudra-Manthan** (the churning of the sea) is woven round the disappearance of the Rajputana Sea and the reclamation of the lands by the Aryans, with the assistance of the south-Indian Dravidians. The periodic overflow of the Nile waters was a matter of vital importance to the Egyptians, and the worship of the Nile became necessarily a matter of religion; the Ganges similarly is of prime importance to the Aryans in north India for their daily life, for irrigation and navigation; and its adoration as the great purifying mother Ganges follows naturally through the myth of the goddess Ganga dropping from heaven on the head of Shankar, the presiding deity on Mount Kailas, and becoming a co-wife with his consort, Parvati the daughter of the deified Himalayas. The monsoon rains causing prosperity or famines to the people of India cannot fail to be important in their religion; but to the early peoples of the Amazon valley, the abundance of rain is a nuisance, and the god of rain is regarded with disfavour.

The evil deity of Egypt was one who caused the hot wind to blow, leading to the soil being dried up and the vegetation parched; India held in disfavour Vritra, the serpent-clouds who kept back the rain till Indra set it free with his lightning. In Scandinavia the malevolent deities were the mountains deified as frost-giants, against whom Thor and Odin carried on a ceaseless war.

In all great religions, which take cognizance of a life after death, heaven is a place of happiness; but man's conception of this happiness in heaven is coloured by his mode of life, his civilization, and his ideas and ideals, all products of his environment. The American Indians' heaven was a happy hunting-ground with plenty of game; the Norse heaven was a place of comforting warmth, and hell a place of chilling cold and mist; the Islamic and Christian hell is a place of eternal fire, and of sulphurous heat. The Arab paradise was conceived as an oasis or a garden, with water, trees and fruit; the Zoroastrians and the Persians had much the same conception of heaven and hell; the Hindus have a similar idea, their **Swarga** or **Vaikuntha** being a cool, breezy and luxurious place, majestic and grand, their **Narka** or hell being a region of eternal fire; to the Hebrews living in the semi-desert region of Palestine, in continual terror of the raids of the desert nomads, heaven means a walled city with gates of pearl and streets of gold, quite in harmony with the Jewish love of articles of high value and small bulk.

In sub-tropical Greece, Mount Olympus and Mount Ida were regarded as delightful places suitable for the habitation of gods. Zoroaster also placed his gods on mountain tops. In cold Norway, the mountains were looked upon with great disfavour and regarded as evil demons whom the gods continually strove to subdue. In India, the gods are supposed to dwell, not necessarily on mountain tops, but in the sky. Brahma, the Creator, was placed, however, on the Pamir plateau, and Mahadeo or Shiva on Mount Kailas, though Vishnu was in a low-lying highly developed plain region of the Vaikunth. The Aryan invaders of India came from the arid lands on the north-west; they were a pastoral people; their chief deity was **Dyaus** (sky); Indra, his son, the rain-god, was of minor rank; but with their residence in India, the change in their climatic environment was reflected in the evolution of Hindu theology, and Indra became the most highly-honoured god. It is thus clear that the religious beliefs of a people depend greatly upon their environment, upon the scenery with which they are familiar and upon the natural phenomena which affect their life profoundly. The religion of men who live in forests is thus bound to be different from that of the people of the wide open plains; the religion of the people who suffer from fog, frost, floods and famines is bound to be different from that of men who live under bright and sunny skies.

The religion of the Hindu and the Buddhist, the Mohammedan and the Christian would naturally show the influences of the chief features of their environment, which though it does not compose the religion nor even necessarily impose its influences too much on it, certainly does mould it to a greater or less extent. Great religions are ethical codes, social philosophies, and metaphysical speculations into the unknown; they are concerned with the ordered well-being of life in this world in complex organizations, and the hypothetical conception of life in the spirit-world; and they try to pierce the veil and unfold the great mysteries of creation, birth, evolution, death and the final goal. These are not concerned merely with the worship of an Indra (rain), and Agni (fire), a Vayu (wind), and Varuna (water-god, Neptune), or of Thor and Odin; they also provide a code for the efficient working of human societies, and prescribe sanctions—heaven and hell—to enforce obedience to the great commandments; and they offer a speculative peep into the unknown.

Equatorial regions, by reason of the laziness and inertia of the people, and polar regions, by reason of the drudgery which dwarfs man's intelligence and imagination, cannot therefore be the breeding places of any but the simplest religions. The tropical and the cool temperate lands are similarly not suitable for the evolution of mighty religious systems ; in the former case, imagination runs riot, and mythology, clothed in rich imagery and replete with poetic fancies, would take the place of religion ; in the latter, the leisure is too little to permit of any abstruse metaphysical speculations ; life in this world is hard enough for them without their diving into the problems of life after death. The sub-tropical region, between about latitude 30° and 40°, is thus the best fitted for the birth of the great religions of the world. Excluding the two Americas and Australia, where the present populations are largely European in origin, the sub-tropical zone of Asia has been the birth-place of the great religions which today sway the hearts of mankind. Of these, Hinduism and Zoroastrianism were evolved in the steppelands of central Asia, the original home of the Indo-Afghan peoples ; Jainism and Buddhism in the plains of the Ganges ; Christianity and Judaism in the arid lands of Palestine ; and Islam in the desert lands of Arabia.

Early **Vedic Hinduism** represents a pastoral religion with great simplicity of thought, and there is a great deal of similarity between this and the religion of the Iranians, **Zoroastrianism,** quite in harmony with the conditions of life in the arid steppelands. The gradual change in the fundamental conceptions of Hinduism, from the Vedic simplicity to the Upanishad complexity in harmony with the progress of the Aryan invaders, from the original steppelands of central Asia to the **Saptasindhu,** the region of the Indus with the Kabul and the five Punjab rivers, and thence to the still better and richer plains of the Ganges is a striking example of the geographical control of religion.

Buddhism, however, was the true and genuine religion of a fertile river plain. The robust vigour and uncouth ruggedness that marked the nomadic shepherd of the steppes now gives place to the soft polish and vivid imagination of the agricultural plains ; the religion changes from the simple worship and adoration of gods to abstruse speculations and high moral philosophy. The softer graces of mankind, forgiveness, charity, hope and mercy, the preaching of **Ahimsa** (that man should not destroy life in any form), and vegetarianism are the products of a fertile river basin ; the doctrines of **Karma,** transmigration of souls, rebirth, **Nirvana** or merger or salvation as the final goal of creation, are the result of a vivid imagination, great intelligence, leisure and the attainment of a high order of civilization. The birth of this native religion was acclaimed by the people, and the alien Hinduism of the Vedas, though modified by the Puranas and Upanishads, was soon displaced. Conversion by the spread of knowledge carried the great new religion to all parts of India, and it captured the hearts of the dwellers in the other monsoon lands of Asia. The great moral code known as **Confucianism** evolved in the Yangtze valley was set aside in favour of Buddhism, which penetrated even into Japan, farther India, Ceylon and the East Indies. Its spread to regions similar to the region of its birth is a striking testimony to its being fully in harmony with the environments of rich monsoon river basins. That Buddhism should have disappeared almost completely from the land of its birth, India, ceases to mystify us when we realize that reformed, or neo-Hinduism, accepted almost the entire philosophy of Buddhism, differing only in the ritual and ceremonies and in the belief in gods and goddesses under the supreme deity—polytheism in monotheism—and diluting the sternness of Buddhist asceticism with a rich mythology; and it thus became more acceptable in tropical India. The progressive evolution of Hinduism to suit altered environments leading it almost to absorb the native Buddhism, and the confinement of Buddhism to the great monsoon lands of the world, bring out very clearly the correlation between religion and geographical environment.

The arid lands of south-western Asia in the Levant gave birth to **Judaism and Christianity.** The frequent references in the Bible to the vine, the fig, the olive, the sheep and the goat are clearly in harmony with the products and environment of Palestine. Christianity is obviously a religion of the Mediterranean region, as is Buddhism of the monsoon region. It, too, quickly spread to Greece and Italy and it was

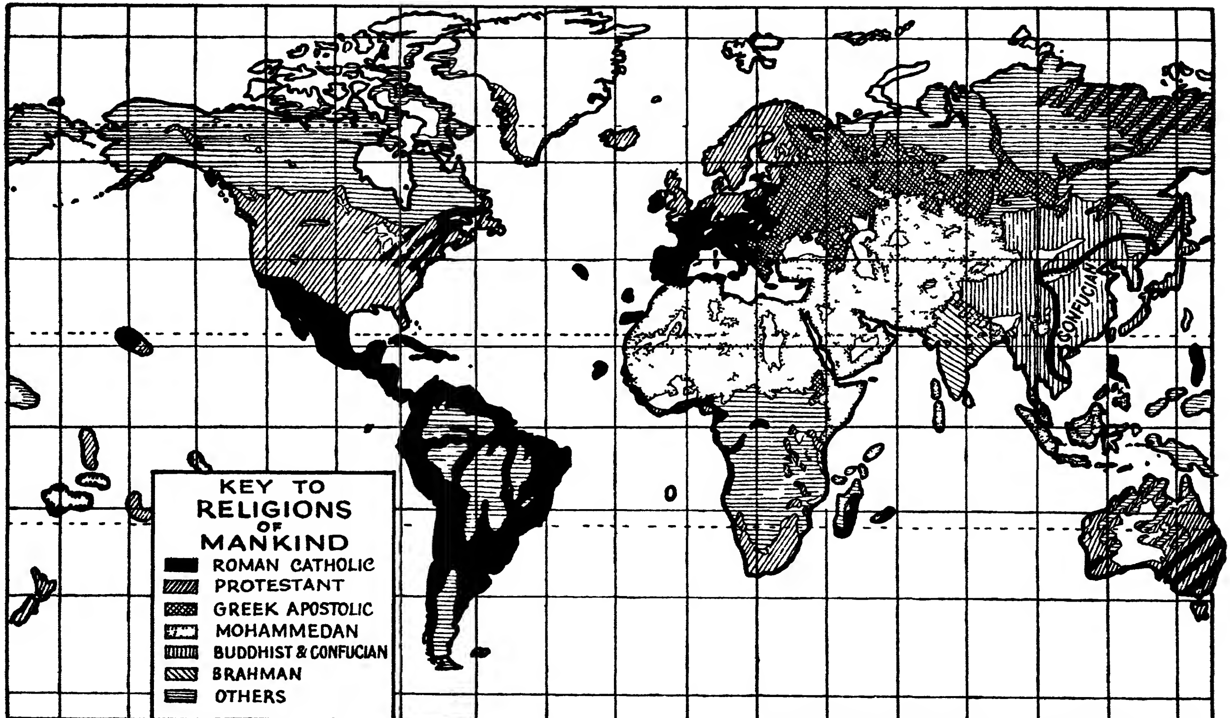

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FIG 83 Religions of Mankind

from Rome, the centre of that great inland sea, that Christianity spread rapidly outwards. Its spread with advancing civilization to northern climates was natural, but it was just as natural for the North to protest against the comparative complexity, imagery, pageantry and rituals of the Roman Church, and to adopt a simpler and purer form of observances. The Lutheran Church in Germany, the Anglican in England and Presbyterianism in Scotland are illustrations of a progressively simpler faith suiting progressively colder climes. That Christianity spread from Europe to the two Americas and Australia and to South Africa is a fact due rather to the colonization of these newly discovered lands than to any geographical affinity between them and its home region.

The desert lands of Arabia needed a sturdier religion than the philosophical Buddhism or the abstruse Hinduism or the practical Christianity, and the great prophet Mohammed introduced **Islam.** The spirit of democracy and brotherhood among the tribes, the suspicion of all aliens and other tribes, regarding all as Kafirs (unbelievers and heathens), strangely different moral standards, conversion by the sword even, if necessary, are all teachings of Islam in harmony with life in deserts; and the rapid spread of Islam in the deserts and semi-desert lands of the world from the Sahara to Mongolia, and even in the southern hemisphere in Africa, reveals the strange adjustment of this religion with geographical environment. Islam is the great religion of the desert, but it has not the same appeal for the people of other regions. That it has penetrated into the river plains of India is an accident of history and largely the result of forcible conversions; but in Mediterranean Spain it failed to gain a permanent hold, nor did it prosper in the Danubian plains. Christianity similarly does not make the same appeal to the people of the monsoon lands or of deserts as it does to peoples in other regions.

7. FESTIVALS

It is reasonable to presume that holidays and festivals among nations have been arranged on some well-advised plan, and not scattered in an arbitrary manner. To unfold the purpose of each national festival is obviously a very difficult task ; for the essential purpose is often concealed in a mass of non-essentials, the truth is hidden in the shell of some legend, and the reality is almost invisible in the midst of formalities. A broad analysis of national festivals, however, suggests that they fall under four classes : (1) those that seek to commemorate a great personage or a great event ; (2) those that seek to afford rest and relief from the monotony of daily work ; (3) those that are designed for merry-making ; and (4) those that are controlled largely, directly or indirectly, by climatic considerations.

Commemoration days. To the first of these groups belong numerous festivals, among all nations, intended to keep fresh the memories of their saints, heroes and semi-divine personages by annual celebrations of their **birthdays. Janmashtami** commemorates the birth of Shri Krishna and **Ramnavami** that of Shri Ramchandra ; and there are in fact commemoration dates for all the incarnations of Vishnu. Shiva, Ganpati, Hanuman and the consorts of various gods, too, have their days. These are not all held to be of equal importance, nor is any one of them held in equal esteem in all the different parts of India. The quality and the locality of the achievements of a hero have largely determined the importance of his **jayanti** in different parts.

The Mohammedans similarly have their Id-i-Milad and the Bara Wafat, and the Parsis have their Zarthost-no-diso and the Khordad Sal. England, too, has many festivals of this type. The saints'-days are minor festivals set apart by the Church in commemoration of these who, by their lives and in their deaths, are an example to all earnest Christians. All Saints' Day on 1 November is the day set apart in commemoration of all good and holy men who have gone before, though it is associated also with fruits, for on the evening before Hallowe'en, the custom of ducking for apples and roasting chestnuts, still prevails in some places. St. Valentine's Day, 14 February, was reckoned in former times as the lovers' day, because of the belief that birds begin pairing on that day. Ireland observes St. Patrick's Day on 17 March, in honour of its patron saint.

Similarly, commemoration days are set apart for great events. In India today we have Armistice Day on 11 November when the great World War came to an end, and Empire Day (24 May) in honour of Queen Victoria, whose birthday fell on that date, and also in celebration of the building up of the unique British Empire. America celebrates its Independence Day and so does Afghanistan. Curiously enough, the anniversary of the Gunpowder Plot is still observed in England as Guy Fawkes' Day on 5 November.

Periodic rest days. The second class is represented by the periodic rest days ordained by all the great religions. Christianity, Judaism and Islam favour rest one day in seven, the first prescribing Sunday, the second, Saturday, and the last, Friday. Hinduism, though evolved in a tropical country, strangely enough does not ordain weekly rest, but prescribes a monthly rest day on **Amawasya** (New Moon day).

The small number, twelve, of the monthly rest days with the Hindus is more than made up for by a large number of festivals prescribed on other counts. In India today the Amawasya has been replaced by Sunday, and the more important of the other Hindu festivals have had to be retained. To these have had to be added some of the important festivals of the Mohammedans, Jains, Parsis and Christians, with the result that India has a plethora of holidays considerably in excess of those warranted even by its tropical climate. Schoolboys and college students everywhere enjoy the largest number of holidays, and business houses and banks in particular the fewest. Banks in England take holidays only at Easter, Whitsuntide, the first Monday in August, and at Christmas. The unbroken intervals were too long and the idea of periodic rest has led in Scotland to the adoption of 1 January and the first Monday in May.

Pleasure days. When, however, the half of the Moon turned towards us is fully illuminated, the energies of men receive a stimulus, and this fact and the poetry of moonlight mark out the **Poornimas** (Full Moon days) as holidays of the third kind designed for merry-making. Generally speaking, therefore, all the twelve **Poornimas** are, with the Hindus, festivals, major or minor. In a rainless tract, or a region of rain throughout the year, where there is no clearly defined rainy season, one expects all **Poornimas** to be regarded alike; but in India this cannot be so. During the monsoon months the Moon can but peep now and then through the dense clouds floating in the sky, and as the essence of the festivals is enjoyment based on moonlight, the four **Poornimas** of the period are hardly holidays at all, unless one of them coincides with a holiday of any one of the other classes. But the Moon breaks out boldly from its cloudy envelope in **Ashwin** (October). **Ashwin Poornima,** usually known as **Sharad Poornima,** is hence a major holiday, people welcoming the Moon by revelling and picnicking in the moonlight on open plains and maidans or the terraces of houses.

The **May Day** celebrations, which are unfortunately dying out in England, are undoubtedly the relic of the Roman **Floralia,** a festival in honour of Flora the goddess of flowers. With the advent of spring, vegetation enters upon a new and vigorous life and early in May plants begin to bloom. May day is therefore a day for enjoyment, pleasure and merry-making. Whit Sunday, corresponding to the Jewish feast of Pentecost, celebrates the birth of the Church of Christ as the result of the outpouring of the Holy Ghost on the Apostles. Apart, however, from its religious significance, Whit Sunday is too near the May Day to escape being included in the pleasure day type of festivals. It is perhaps rather taking the place of May Day for the townsfolk and is celebrated, in conjunction with Whit Monday bank holiday, as the beginning of summer.

Seasonal festivals. Chaitri year and the vernal equinox. By far the most important group of holidays is, however, controlled by geographical considerations, largely climatic. Nature clearly marks out as great holidays the days when one season gives place to another; these are the two equinoxes and the two solstices. The vernal equinox falls on 21 March. The termination of winter and the advent of spring is obviously a day well suited not only for observance as a holiday, but for observance as the most important of holidays—the New Year's Day. This period corresponds to the month of **Chaitra** in the Hindu calendar, and the first of **Chaitra** is therefore observed as the scientific Hindu New Year's Day. India is, and has been for ages, predominantly an agricultural country; and it is no wonder that agricultural considerations also influenced the determinations of holidays. The **rabi** harvest is gathered by March; this fact therefore materially adds to the suitability of **Chaitra** for the commencement of the New Year of the **Shaka** (era) of Shahivahan. The adoption of the 1st of April for the commencement of the financial year in India is but a recognition of the extreme suitability of **Chaitra** for ushering in the New Year in the country.

The vernal equinox seems to be the basis for the New Year in many other countries. Iran has its Jamshedi Navroz on 21 March, and a section of the Parsis, the Faslis, too, change the year on that date. Even the birthday of the legendary hero, Shri Ramchandra, falls in this period, early in **Chaitra.**

Kartiki year and the autumnal equinox. The autumnal equinox falls about 23 September, which corresponds to Ashwin. The first day of the next month, Kartika, is hence another day which introduces the New Year of the **Samvat** (era) of Vikramaditya. The importance of this period is considerably increased by the fact that the great **kharif** crops are harvested by September and October. India thus observes one or the other of the two equinoxial periods for the commencement of the New Year, the relative importance of the two harvests determining in general which of the two periods should be adopted in a particular region.

Ashadhi year and the summer solstice. The summer solstice falls about 21 June, which corresponds to the latter part of the month of **Jaishtha.** As no great agricultural importance attaches to this period, the first day of the next month, **Ashadha,** is obviously of less significance for the commencement of the year. Further, the climatic transition which this solstice marks is obscured by the onset of the monsoon, except in those parts where the rains are usually scanty or late. This, for example, is the case in the Punjab and the northern parts of Kathiawar where, as a matter of fact, the New Year's Day is observed on the first of Ashadha, and the years of the Yudhishtir era change in that month. Co-operative societies, too, have found it desirable, in the interests of the agriculturists whose financial interests they serve, to adopt 1 July for the commencement of their New Year.

Makar Sankranti and the winter solstice. The winter solstice falls on 22 December. Christianity having been evolved in the Mediterranean region with winter rains and dry summers, this solstice was of great importance agriculturally to the early Christians. It is easily intelligible, therefore, that we find them adopting this period as the period of their greatest holidays—Christmas, and the first day of the next month, January, as the New Year's Day. In India, the winter solstice is not important for agriculture and does not mark the commencement of the new year in any part of the country. But it introduces a great change in her wind system, the north-east monsoon being by that time definitely established all over the land ; and the exact date of the solstice is observed as a holiday by the Hindus. But the Hindu system of astronomical calculation differs from the Christian; and the solstice, according to the Hindus, falls 23 days later, that is on 14 January, corresponding to the month of **Pausha.** This day is known as the **Makar Sankranti** (Capricorn-transition) or the **Uttarayan** (northward turning). It is the holiday for kite-flying in coastal towns and ports ; the roofs and terraces of houses are alive with men, young and old. The flying of kites on this day seems to be a rough test of the change in the velocity and direction of the prevailing winds.

Whether the two equinoxes and the two solstices are utilized for the commencement of the New Year or not, there is no doubt that these represent four important turning points in the year, dividing it into four quarters. In India, apart from the year-change, the **Holi** and the **Divali,** the **Makar Sankranti** and the **Ashadhi Ekadashi** mark off the four quarter periods. Great Britain has its quarter-days too. Lady Day (25 March) commemorating the visit paid by the Angel Gabriel to the Virgin Mary, Midsummer Day (24 June), Michaelmas Day or the Feast of St. Michael (29 September), and Christmas Day (25 December) are the quarter-days observed in England and Ireland. Scotland, however, probably owing to her longer winters and more severe climate, observes them on Candlemas (2 February), 15 May, Lammas (1 August) the festival for new corn, and Martinmas (11 November), the birthday of St. Martin.

Devshayani and Prabhodhini Ekadashis and the south-west monsoon. Apart from the solstices and the equinoxes, however, the most striking climatic phenomena in India are the monsoons. The commencement and the close of the monsoon period may then very well be the bases of two important holidays. Though the monsoon sets in normally in June, in India as a whole the south-west monsoon conditions are definitely established by the first week of July, which corresponds to **Ashadha.** The definite termination of the south-west monsoon proper falls in the first week in November, corresponding to the early part of **Kartika.** For this reason, the **Devshayani Ekadashi** in **Ashadha** and the **Prabhodhini Ekadashi** in **Kartika** are observed as major holidays. During these four months, marriage celebrations are prohibited, and the prohibition, usually ascribed to the gods being wrapt in profound slumber, can be more rationally explained as showing the impracticability of festivities on a large scale during the season of heavy rains. The marriage season begins in real earnest in the month of **Magh** (February) after the Makar Sankranti, for the intervening period from the Prabhodhini Ekadashi is that of the retreating south-west monsoons which gives rain to some parts of India.

St. Swithun's Day (15 July) is in honour of St. Swithun, Bishop of Winchester, who died in 862. The legend is that the saint prevented the translation of his body to the choir, when he was canonized, by sending heavy rain on 15 July, the date fixed for the ceremony, and that this heavy rain which continued to fall day after day for forty days, led to the abandonment of the idea of removing the body. The origin of the belief arose from the simple meteorological fact that rain in England is generally to be expected from about 15 July, the dog-days from 3 July to 11 August being a period of great heat.

The coco-nut holiday and resumption of commercial intercourse. The rains, however, are not continuous in India even during the four monsoon months. An important break occurs usually during August, corresponding to the middle of the Hindu holy month, **Shravan.** It is then that conditions in the seas become sufficiently practicable for sailing vessels, and sufficiently favourable for the resumption of coastal trade and commercial intercourse by sea between the different parts of India and the neighbouring countries. The **Shravan Poornima** is thus a holiday not of the poornima or merry-making class, but a commercial holiday to celebrate the close of the stormy part of the monsoon and to mark the departure of merchants. On this day, relatives gather together at the house of the departing merchant to wish him *bon voyage* and a safe return. The Hindu family being usually a joint family, all the near blood-relations have already had occasion to tender their good wishes. The only near relation who probably has not had the opportunity is the sister, and it is on this day therefore that she visits her brother, blesses him, and ties a charm round his wrist to ensure his safety on the seas. The **gurus** (priests) do the same and naturally they and the sisters receive parting gifts from the departing merchant. The assembled people join in a feast in honour of the occasion ; and in the afternoon all make for the seashore or the river bank. There the waters are worshipped and offerings are given to appease **Varuna** (Neptune). The offering is a substitute for a human being and this is, therefore, usually a coco-nut. Many people go about in boats, the idea presumably being a sort of a preparatory cruise.

Dassera and return home. The merchant returns to his native place in a couple of months and quite naturally the return must needs be as well, if not better, celebrated. This is done on **Dassera** or **Vijaya Dashmi** which usually falls in the first week of October. The charms are untied and a happy reunion of lovers take place. This is therefore essentially a lovers' day. But these features of the Dassera festival are considerably obscured by other considerations. Kings and princes were often at war with one another and the campaigns were almost annual affairs, the activity of the armies ceasing with the setting in of winter. The warriors, therefore, returned home for winter quarters by the beginning of Ashwin. Groups and parties would pour in from day to day, till the final triumphal entry would be made by the king at the head of his victorious troops on Dassera, the tenth day of the month. During the preceding nine days people vied with one another in their demonstrations of loyalty and devotion to their returning ruler by exhibiting every evening on their verandas, images of the king and his **sirdars**, as on similar occasions nowadays we adorn our house-fronts with flags and photo prints. These nine days are known as the **Navratri.** Women fast all these days, the reason probably being their increasing anxiety about the fate of their loved ones in the wars. The Dassera festival is thus a very important festival, celebrating the return home of merchants and soldiers, and its importance is enhanced by historic associations, such as Rama's return to Ayodhya and the victory of the Pandavas over the Kauravas. Dassera is also celebrated as the birthday of Bhagwan Buddha.

The Holi festival and tropical diseases. A tropical and monsoon region like India is subject to two periods when disease stalks boldly through the land. Diarrhoea, dysentery, cholera and smallpox rage violently in summer, and the beginnings of a rise in mortality are perceived in April. Sanitary precautions have to be taken on a large scale to control the diseases, and as these soon become epidemic, the atmosphere of towns and villages must be purified. Fire is the best destroyer of germs and purifier of air. A day is therefore appointed, the **Falgun Poornima**, known popularly as the **Holi** festival, in March, for the simultaneous lighting of fires at each square of the town or village. The fires are fed, among other things, by cow-dung cakes, ghee and coco-nuts, all of which help to destroy germs effectively. Custom ordains that men and women should walk round the fires several times and secure immunity from disease by thus inhaling the purifying fumes. This walking round is specially prescribed for newly-married couples, who, it appears, are held to be more liable to diseases than the others. These evening rounds have to be preceded by a fast, intended evidently to purify the human system. The Holi festival is followed by a day of riotous mirth, indicative of the advent of spring and of the approaching departure of warriors for their annual campaigns. These revels have often deteriorated to a kind of Saturnalia—mud-throwing, spraying with coloured waters and obscene jokes.

The great **Easter festival** of the Christian commemorates the resurrection of Christ from the dead. Easter Sunday is the first Sunday after the first Full Moon after the vernal equinox on 21 March. Spring commences a fresh cycle of vegetable life, and its advent is naturally celebrated more or less by all nations, by a **vasantotsava** or a spring festival; and Easter, like the Holi, is based on the Poornima or the Full Moon day. Easter eggs signify the coming to life of that which is apparently dead, and are emblematical of the Resurrection. The Friday before Easter Sunday is Good Friday, commemorating the crucifixion, death and burial of Christ, and the Monday after it is Easter Monday, included in the list of bank holidays.

The Dipavali and malaria. There is another period, October, when malaria rages in India in all its fury. To guard against this, a thorough cleaning of houses is essential; and this work is prescribed in the last half of Ashwin or the close of the Kartiki year. Houses are coloured and whitewashed, floors are renewed by an application of cow-dung, the furniture, lamps, utensils—everything in fact—is thoroughly cleaned, and on the last day of the period, the **Dipavali,** the feast of lamps, illuminations mark the close of the year and the close of the cleansing labours. The fireworks usually let off on this day seem partly intended to purify the atmosphere by fumigation. Even where the Dipavali does not mark the close of a year, it is accepted generally as marking the close of the commercial year and the festival, like all year-ending festivals, is spread over several days. The **Dhantrayodashi,** two days before, is the day dedicated to the worship of Lakshmi, the goddess of wealth and happiness; the merchants close their old books and open new cash-books, ledgers and journals with due ceremonial; and bonuses and presents are bestowed upon the children and dependants of the family, as well as upon the clerical and menial staffs. The Parsis have similarly several days of feasting and prayers at the close of the year, the **Gatha Gambhars**; the Mohammedans have their **Muharram** week; while the Christians have their **Christmas.** The festival begins on **Christmas Eve** on 24 December; 25 December is **Christmas Day** in remembrance of the birth of Christ; 26 December is **Boxing Day** or **St. Stephen's Day,** and corresponds, in a way, to the **Dhantrayodashi** of the Hindus. Trade apprentices called upon their masters' customers on this day with a box, in the hope of obtaining a gratuity. The day of trade apprentices is really over, but the custom still survives in the so-called Christmas-box. The season closes with **New Year's Day,** though it might perhaps be taken to extend up to the **feast of Epiphany** as the Dipavali season similarly extends to the feast of the **Akshay Navmi,** nine days after.

Most religions have prescribed **fasts** probably as a hygienic and self-disciplinary measures, but the season of fasting varies in harmony with the climatic seasons in different lands. Hinduism prescribes periodic fasts on the **Ekadashis,** the eleventh day of lunar fortnights, though the fasts are unfortunately giving place to feasts often followed by physical derangement. Further, the monsoon months are considered a season bad for digestion, and in the **Chaturmas** (these four months) only one meal per day is allowed. Of these four months, the central, **Shravan,** is considered holy because of its association with the birth of Shri Krishna, and those who do not or cannot observe diet-restriction for all the four months, content themselves with this one month's dieting only. The **adhika masa,** or the intercalary month, which is added once in about three years, is also a holy month and a month for fasting. Jainism strongly enjoins fasts, the **Pachusans** in September being the principal fasting season. The Mohammedans have their month of fast in **Ramzan** and the Christians have theirs in winter. The season is called **Lent** and extends over a period of six weeks. It commemorates the forty days' fast of Christ in the wilderness and is regarded as a season for self-denial and self-discipline. It immediately precedes Easter and would therefore commence from about 15 February. The first day of Lent is **Ash Wednesday** when penitents received from priests assurances of the Divine Forgiveness. In view of the approaching season of fasting, the penitents partake of a good meal the previous day; the custom still lingers in the eating of pancakes on this particular day, Shrove Tuesday. The last week of Lent, the week immediately preceding Easter, is known as Holy Week, the first day of which, **Palm Sunday,** commemorates Christ's triumphal entry into Jerusalem.

Food on holidays and crops of the season. Hindu custom enjoins not only a particular day as a holiday, but also frequently enjoins the manner of its observance, even prescribing the food in some cases. The regulation of food seems to be based on the harvest at that particular time of the year. Thus, on the **Sharad Poornima,** people usually take **pahua** (parched rice), rice being the crop of the season, with milk from cattle fed on the rich pastures of the rains. Sugarcane figures prominently on the **Dev-Dipavali,** and as **gur**

(jaggery) from the canes can be expected in about a month and a half, it is prescribed for the **Makar Sankranti.** On this day, **til, jawar** and green gram, the crops of the period, are also widely used. **Jawar** and gram would, however, be placed on the market some time later, and it is therefore to lessen the inconvenience of a fast on the **Holi** festival that parched **jawar** and parched gram are recommended. It is also about this time that the **gur** has been refined into sugar, and we find sugar toys and cakes much in use at the festival.

We cannot fail to realize therefore that environmental influences play a very significant part in the life and activities of man, and that though man is not the slave of his surroundings, he does not escape the control of his environment, which forms his character, dictates his clothing, influences his architecture, prescribes his occupations, colours his literature, shapes his religion and regulates his festivals. The importance of the place-factor in the study of man and his progress is thus truly great, and modern geographical studies are increasingly associated with the proper understanding and analysis of the correlation between man and his environment.

Chapter VII

DEVELOPMENT OF HUMAN LIFE

EVOLUTION OF LANDS AND LIFE-FORMS

The precise time when man made his first appearance on the Earth is still a matter of uncertainty; but, as time is reckoned in geological history, man is but a recent arrival on the Earth. Life forms were there before him, but it is a study of the rocks and the fossils they contain that gives us a glimpse of the gradual development of life forms culminating in the evolution of man. We trace a long succession of life-forms, changing, developing, and evolving in diverse ways. The earliest of these are curious beetle-like creatures, queer plant-animals, strange whorled shells; these are succeeded by the earliest armour-plated fish and a great variety of other marine organisms. Vegetation then comes upon the scene and dense forests and steaming jungles of gigantic trees flourish. The seas are alive with giant fish-lizards; the lands are overrun by unwieldy reptiles and the air is dominated by strange bat-bird reptiles. The era of the great reptiles passes and the stage is occupied by the earliest mammals, the forerunners of the horse and the elephant, the boar and the lion. These, through millions of years, pass into further complex forms and life progresses onwards until it achieves its highest development in man.

Stratified rocks are usually classified into **groups, systems** and **series** corresponding to geological eras, periods and epochs, respectively. The following table shows the main divisions of these groups.

Groups (**Eras**)	**Systems** (**Periods**)
Eozoic (dawn of life)	Archaean or pre-Cambrian
Palaeozoic or **Primary** (ancient life)	Cambrian Silurian Devonian Carboniferous Permian

Groups (Eras)	Systems (Periods)
Mesozoic or **Secondary** (middle life)	Triassic Jurassic Cretaceous
Cainozoic or **Tertiary** (recent life)	Eocene Oligocene Miocene Pliocene
Quaternary	Pleistocene and recent

Eozoic group. The **archaean** rocks are the oldest ; large areas appear at the surface in peninsular India, in the Himalayan area, and in every continent, and probably lie below the stratified rocks everywhere. Some of these are sedimentary rocks metamorphosed under great pressure. The absence of fossils does not permit us to form any idea of life on the Earth in this very early period. But the great tiltings, twistings and contortions of these rocks suggest great Earth-movements. The upper, or younger, members of these archaean rocks, known in Indian geology as the **Dharwar** series, are well known for their economic importance. Iron ores of great richness and purity are found in the Central Provinces and Orissa ; iron and manganese ores in Sandur in the Bellary district and the Bababudan hills of the Shimoga district in Mysore ; and gold in Kolar, Anantapur and the Nizam's territories. The Himalayan area was covered by the **Purana Sea,** which was bounded on the north by the Tibetan continent and extended as far as China.

Palaeozoic group. The palaeozoic group is fossiliferous ; the strata that separate the fossils of early life-forms from those of the great reptiles are very thick ; this suggests the passage of a very long space of time and the very slow and gradual development of life upon the Earth. In India, this era from the Cambrian to the permo-carboniferous period is known as the Dravidian epoch. The **Purana Sea** disappeared and the Himalayan area became dry land. The extensive series of marine fossil-bearing rocks to the north suggests that in the Tibetan area to the north of the Himalayan chain lay the southern shores of the sea which extended over most of Asia during palaeozoic and mesozoic times. The complete difference in the character of deposits on the two sides of the Himalayan area indicates that the two areas were separate from the very earliest times, and have had different geological histories.

The rocks of the **Cambrian** series cover extensive areas of the continental land masses. Some of the stones in these rocks show distinct glacial action, which warrants us in the belief that glaciers must have covered some part of these lands. At the same time, the presence of desert-sand suggests that, for some time, these lands must have been deserts. The fossils reveal marine organisms like the trilobites and the graptolites which crawled on the sea-beds. The **Tibetan Sea** extended to China and even as far as North America; in the south it spread to what is now the Salt Range in the Punjab. It was not yet, however, connected with the European Sea.

The **Silurian** system marks the appearance of the first vertebrate animals, the earliest fish and insects. Dry land began to appear and the great branching seaweeds of earlier periods gradually adapted themselves to land conditions, and have left traces of a luxuriant land vegetation in the rocks. The Tibetan Sea retreated northwards and left the Salt Range area dry, and became connected with the European Sea.

In the **Devonian** period, a great uplift took place, and the ocean bed was in some places gradually elevated so that new continents were formed. It is believed that during this period Europe and America were connected to form a great northern continent, and that South America, Africa and Australia were similarly connected to form a great southern continent. The **Tibetan Sea** covered all the northern portion of the Himalayan area, extended eastwards to the Shan States and Burma, westwards to Kashmir, the Hindu Kush and Afghanistan, and northwards to the Pamir Plateau. The **old red sandstone** is the best known and distinctive rock of this period. As regards life-forms, the Devonian period is often called the **age of fishes.** Lakes and seas presented an infinite variety of fish, large and small, toothed and armed, and some had both gills and lungs.

The **carboniferous** system includes the coal deposits which are of great importance in the economic development of countries today. In England, where the names were first given, it has three great series: **carboniferous limestone, millstone grit** and the **coal measures.** The coal measures consist of alternate beds of sandstone, clay, coal and limestone. It is believed that the coal-bearing areas must have been long submerged sea-beds on which the silt and rock waste brought by large rivers were deposited. With the gradual emergence of dry land, the great moisture of the atmosphere and the high temperature provided very suitable conditions for the quick growth of vegetation, and dense forests occupied much of the new land area. Subsequently, the climate changed and the forests decayed; their remains were buried under layer after layer of aqueous rock material, and under this enormous pressure with exclusion from light and air, were changed into coal. In this period the **amphibians** were probably developed from the fish. In these animals lungs displaced gills altogether, and fins became stumpy, web-footed legs.

In the **Permian** period, large tracts of the Earth's surface seem to have been subjected to great volcanic activity and great mountains were formed. A mountain range stretching from south Ireland to Germany, the Pennine Chain, the Appalachians in America, were all upheaved during this period. Large parts of Europe and America were, however, buried under huge glaciers about the same time. Towards the close of the palaeozoic era, new forms of fish and new types of animals were evolved and vegetation was established on land.

Part of present-day India became in this period an integral part of the great continent known in geological history as **Gondwanaland,** which extended to South Africa, Australia and South America. The drainage of this continent was in a northerly direction opening into the Tibetan Sea; the mountains were somewhere in central or northern India. Except the Aravalis, which are thus a relic of these ancient mountains, all have disappeared. During this period, the Earth-movements elevated mountains and also deepened and widened the sea in the north, which spread to the Salt Range area and extended to the present Mediterranean, covering northern Africa in the west and extending also to the east, thus completely separating Gondwanaland from the land to the north. This **Central Asian Ocean** is known in geology as the **Tethys.** The Gondwana series is well known for the **coal-bearing** seams of India, which occur in the lower deposits of the series.

Mesozoic group. In the **mesozoic group** the evolution of new life-forms continued and the predominating type was the great reptiles ; though we begin to find early birds and mammals. Indian geology speaks of this period as the **Aryan epoch.**

The characteristic rock of the **triassic** system in some areas is the new red sandstone. In this period, Britain was an arid region to the east of a great western continent. The triassic rocks yield but few fossils. The Tethys gradually began to recede westwards. Most of China became dry land, but the sea extended from eastern Afghanistan into Baluchistan and also from Kashmir through the Pamirs to Bokhara.

The **jurassic** period was essentially the **age of reptiles.** Some swarmed in the seas ; some, the **pterodactyls,** flew in the air ; and some moved slowly in the swamps and marshes of the lowlands. The earliest bird—the **archaeopteryx,** also belongs to this period. The jurassic period saw great changes in the distribution of land and water over Asia. A large continent corresponding to Gondwanaland, and marked by fresh-water beds and coal seams, appeared on the northern shores of the Tethys. The Tethys still remained connected with the mesozoic Sea of Europe and penetrated even to Rajputana and Cutch.

The **cretaceous** system has **chalk** for its characteristic rock in Britain and several other countries. In this period a gradual subsidence of the land surface of continents took place, and the waters of the deep ocean spread over large areas. Southern Europe was thus submerged and received the minute shells of the countless millions of the tiny creatures from which have been formed the great chalk beds extending from England to southern Russia. Towards the end of this period, the reverse process took place, and parts of the sea-bed were again uplifted into dry land.

During this period, the southern sea encroached on the Narbada valley and covered Sind, the southern side of the

Gondwana continent, Trichinopoly and Pondicherry areas and extended as far as the Shillong area in Assam. The land connexion between India and Africa still persisted, however, and Gondwanaland stretched as an unbroken land from southern Africa across India in a north-easterly direction as far as Assam, covering what is now the Indo-Gangetic valley, and connected also with Australasia by an isthmus along the Malay Archipelago. It thus completely separated the southern and eastern Pacific from the great central and northern ocean. In later cretaceous and early tertiary times, this ancient continent began to break up. A strait appeared between India and Madagascar; a narrow arm of the sea penetrated through the depression now occupied by the Indo-Gangetic valley. The Tethys became shallower; the shore-line began gradually to recede farther and farther north; the Himalayan area changed from a marine into a land area. The Earth-movements were intermittent, till, on the site of the mesozoic sea, there arose the loftiest mountains. As a precursor of this, volcanic action on a large scale in peninsular and extra-peninsular India led to the intrusion of immense lava masses into pre-existing rocks, and the granite which forms the core of the Himalayas is to a large extent the result of the igneous activity of this age. The Deccan was also covered with a succession of horizontal lava sheets, with associated beds of volcanic ash and fragmentary material. One of the earliest results of this upheaval was the breaking up of Gondwanaland by the submergence of large segments and the obliteration of the land connexion between India and Africa; and this was the beginning of the gradual advent of the present geographical features of India.

Cainozoic group. In the **cainozoic** or tertiary group of rocks we meet with forms of vegetable and animal life resembling those of the present day.

In the **eocene** period, many forms of reptiles disappeared and **mammals** took their place. During the early part of this period, a great subsidence of land in one part resulted in the submergence in another of the supposed continent of Atlantis, and this disturbance was accompanied by great volcanic activity. The Tethys retreated generally, though the Ladak basin in Kashmir persisted till middle eocene times.

The compressional movement attained the greatest intensity after the eocene period, and the **miocene** period was one of intense folding and fracturing, which resulted in the uplift of the great mountain systems of the world, the Himalayas, the Alps, and the Atlas mountains. The persistent concomitant subsidence between the newly-formed mountains and the more central parts of India gave rise to a trough, in which tertiary and quaternary deposits were laid down. The mountains rose higher and higher and the trough subsided deeper and deeper, and became a depository for accumulating sediments. The trough extending from Assam to the Punjab received the drainage of the newly-formed hills to the north and of the old Gondwanaland to the south, and formed a gulf in which sediments were deposited. These sediments now contain coal and petroleum. There was a constant struggle between continued subsidence and the deposition of silt ; and in later eocene stages, the former being unable to keep pace with the latter, salt lakes, marshes, lagoons, with occasional fresh water channels or rivers came into existence. West of Naini Tal, this gulf was continued by a river flowing westwards into lagoons and salt lakes opening into a marine gulf as Sind was approached. At the end of the miocene period, all lagoons and lakes gave place to a big river opening into the sea by an estuary in Sind, a forerunner of the present Indus.

Quaternary group. In the pleistocene period of the **quaternary group,** the whole of northern Europe and America was in the grip of ice. In Britain it reached as far south as the Thames, and carried polar flora and fauna. The mammoth roamed the lands, and mammals closely approaching modern types lived farther south. This age is, however, more significant for the first appearance of the earliest man. During all these millions of years, life went on advancing slowly but steadily, through bewildering and wonderful changes, and evolving progressively higher types until the process culminated in the coming of **man.**

2. PREHISTORIC MAN

To get some idea of the progress of man from his early prehistoric days, we have to depend upon the remains, embedded in the rocks, of his handiwork, his bones, and bones of animals, and their location. The **graves** of prehistoric man have been an important source of knowledge of him, his mode of life and of his ideas and ideals. They themselves are veritable books of knowledge, and the many objects, preserved by them, such as bone pins, ornaments of jet, bone, horn, tusks, jewellery of gold and bronze, and pottery yield a great deal of useful information about his skill and progress. His refuse, accumulating outside his hut or in his cave, is another source of information for these refuse heaps, the **kitchen middens** as they are called, give us an idea of his food, of his prowess and his use of fire. **Tools and weapons, remains of prehistoric buildings** and of **art work** and the **soil** all help us to gain knowledge of the early man, while the **primitive** man of today also greatly enables us to understand the life, ideas and outlook of his early forefathers.

Opinion is not unanimous as to the location of the first home of mankind. Some think that Africa was the home of the first man, inasmuch as its warmth and fertility would make for easy conditions of life, while others hold that the very easy life there must have retarded his development, and man in such a region could never have developed the strength and energy which he seems to have possessed. Effort, enterprise and earnestness are the best stimuli for human progress. Some therefore think that the Mediterranean region was the cradle of mankind, while others suggest that the lowlands of central Asia were man's first home. Remains of very early man have been found in many different places; they have been discovered in France, Germany, and England, and the skull of the most primitive, and therefore perhaps the earliest type of man was recently found in Java. The problem of *where* man first lived does not therefore admit of easy or early solution, while the problem regarding *when* man lived is scarcely easier. It is generally agreed, however, that the earliest man could not have been born less than 250,000 years ago, though there are some who place the beginning of humanity at 500,000 years ago.

The Stone Ages. Early man has left, in his tools and weapons, the most widespread and the most instructive records of his life and progress, and the material used for these has given us a basis for classifying man's development in several stages. The first three of these were of stone, but man shows definite improvement and greater skill in each stage. The earliest man had to be content to carry on his work with eoliths, stones to which he gave a jagged edge. Man now prides himself on his ever increasing mastery of nature; in early days, however, he seems to have been the wretched slave of his surroundings. He could not shape or construct anything; he could not sew together the skins of small animals for his clothing. And yet he had to protect himself against wild beasts such as we, with all our modern weapons, still fear to face, and prefer to avoid. The eolithic man thus seems to have been helpless and defenceless. But he managed to save himself from falling prey to them or from being starved off the Earth. He lived on fruits, seeds and small animals and sought shelter in caves, hollows or trees.

The Palaeolithic Age. The Early Stone (**eolithic**) Age, was succeeded by the Palaeolithic (Old Stone) Age which is believed to have lasted 2,000,000 years and ended about 50,000 years ago. During this age there lived, in Europe, animals of warm and cold climates, huge and fierce animals such as the bear, tiger, and cave lion as well as the reindeer, bison and beaver. This suggests great climatic changes in Europe during this long period of time, when warm and cold climates alternated, leading to northward or southward migration of the animals.

Between two of these long, cold, glacial periods, palaeolithic man made his appearance in Europe. When the climate was milder he lived in the river lowlands, so that his own bones, his tools and weapons and other records are found in the river drift or deposits. Hence he is called **drift man.** Progress was very slow indeed until near the close. In 100,000 years, the drift man only learned to fashion his stone implements a little better. Agriculture, archery, domestication of cattle, pottery and weaving were unknown to him; probably he wore no clothing and had no articulate speech. He had probably no tribal organization; only family groups existed with him. The use of fire was yet unknown. The gradual establishment of the cold conditions forced him off the open valleys to the shelter of the caves, and the man of this period is known as the

cave man. The animals of the warmer climates retreated to the south, leaving the country to the mammoth and rhinoceros, cave lion and cave bear. Little advance was made by this **mammoth man.** He acquired perhaps a little greater skill in the chipping of flints, and introduced a greater variety of form. During the next Ice Age, when glaciers covered parts of southern Europe, and polar animals such as the reindeer roamed in large numbers over the great European plains, the **reindeer man** lived, and made comparatively great strides. Stone lances and javelins, harpoons, needles, implements and tools were added to his possessions. Social organization improved and man lived in groups in caverns. He wore clothing and learnt to use fire. He attained considerable skill in drawing and carving, and seems to have risen to the level of the modern Eskimo. As the Ice Age came to a close and more temperate conditions were established, the reindeer man and his reindeer retreated northwards with the retreating ice.

The Neolithic (New Stone) Age. A new race seems now to have come upon the scene, having developed, perhaps, under much more favourable conditions, such as those prevalent in western Asia, northern Africa or southern Europe. Neolithic man did not live in caves or hollows. He depended no longer solely on hunting for his food; he conquered nature a little more than his predecessor, the palaeolithic man; and his cattle-rearing and some little primitive agriculture gave him a settled habitation and a systematized life and occupations. He learnt to build houses and to sew skins into strong clothing. The family groups developed into a tribal organization for mutual help and protection.

Neolithic remains are numerous and are found in many different areas, and it is believed that the population had grown largely since the Old Stone Age. The tools and implements characteristic of the New Stone Age show a definite improvement in shape, variety and polish. The human remains in the **kitchen middens** reveal that these people had progressed in their physical and mental characteristics; they were taller, better proportioned and more human in appearance. The forehead, jaws and teeth are much better shaped and suggest a higher order of intelligence. The neolithic man learnt the use of the bow and arrow. His lake dwellings on platforms erected on strong piles driven into the bed of the lake, and his stone monuments, so common in all western Europe and even found in India, stand today as unchallenged evidence of the existence and development of the widespread, intelligent and progressive people who were our predecessors on the surface of the Earth.

The Bronze Age. The Stone Ages ended about the dawn of history and covered about 2,000 years. Though the period was short, progress was much greater and more rapid. Once the beginnings of progress and development were made, once the start in man's career of the conquest of nature was begun by the neolithic man, further achievements followed soon enough. His struggle for existence, for food, clothing and shelter was less hard; and he began to observe the sky and stars, to launch boats on water, to tame cattle, sheep and goats, and to raise crops. Society was better organized, men learned to co-operate with one another for internal peace and progress, and protection against foes without. Language grew; trade came into existence, and even money as the medium of exchange was invented. During this stage, the Bronze Age, great states arose on the eastern Mediterranean shores.

The transition from stone to metal was not sudden; it was a gradual change, and stone continued to be used long after metal tools and weapons came into use. Copper is fairly widespread, and is often found almost pure; but its softness makes it of very little use as a tool or weapon. Tin was therefore mixed with it to form bronze, and the introduction of bronze was a great step forward. Two distinct stages can be marked in the Bronze Age. The first is the **stage of imitation,** so that what used to be done in stone was now done, and done better, in bronze. The second stage, or the **age of beautiful bronze,** gave to the weapons, tools and other products, greater variety, improved design and better finish. Artistic products and inlay work were also common.

The Iron Age. Bronze was succeeded by **iron** in the lands of the eastern Mediterranean on the threshold of history, and the progress of man in this Iron Age need not be surmised from his remains, but can be gathered from his records, which form more valuable sources of information in the historic times that now followed. In these last 3,000 years of the Iron Age, the progress of man has been phenomenally rapid in every direction.

3. EVOLUTION OF PRIMITIVE OCCUPATIONS

The primary needs of mankind, whether primitive or advanced, are food, clothing and shelter.

Once these primary needs have been met, man attempts to satisfy his cravings for something higher and better than things needed merely for existence. He strives for better food, better shelter and better clothing, for greater ornamentation to flatter his vanity or for greater comfort and means to save avoidable toil and trouble. In these strivings, he gathers knowledge, which spurs him on further and enables him to achieve his higher aspirations. From the satisfaction of bodily needs, he turns to the improvement and satisfaction of the mind. The further man advances, the less content he is to eat, drink and be merry, and the more anxious he is to satisfy his higher nature—one of the characteristics which distinguish him from the lower animals. The early occupations of mankind were therefore those which aimed at the satisfaction of the primary needs of man, and were few. It was only when these occupations ceased to be laborious and to occupy the whole time of the people that higher occupations were developed. Differentiation of occupations is thus the result of man's progress and civilization.

The natural occupation of prehistoric men was **hunting.** They hunted and gathered fruits, seeds and roots ; they chased animals and caught fish. These early occupations yet live on among primitive people ; among advanced people, they survive in special environments as an important occupation or provide sport and amusement. Experience and observation taught these early people how to carry on their business ; but they could not yet ensure a regular supply of food by domesticating animals or by growing crops. The average man continued thus to live from day to day without making provision for the morrow, but the more intelligent men among them, by observation and thought, soon developed beyond that stage. The growth of plants and the production of fruits and seeds soon attracted their notice, particularly in fertile countries, and they soon began to sow seeds and raise fruits for themselves.

With a sufficiency of animals and plants in most regions and with the increasing efficiency of man, a sort of division of labour soon developed. The male hunted, fished and built, the female tilled, ground, cooked, wove, and constructed pots. The **discovery of fire** led to much further advancement; man learnt to produce it when wanted and to put it to numerous uses. The observation that water was held by clay bottoms in the depressions in the surface taught the making of sun-dried clay pots, which were made stronger by the use of reeds and twigs to provide a framework which was covered with clay. Thus early man developed **pottery,** braiding and plaiting and wicker-work. In a similar manner, spurred on by necessity, and taught by observation and experiment, man learned to construct rafts and boats for transport on lakes and rivers. The excellent shelter afforded by big and leafy trees taught him to make use of their branches and twigs to give a framework for a hut, which was then covered over with mud or skins. Even now the Papuans in New Guinea have not advanced much beyond this stage in house-building; they build their huts on crude platforms made on large branches of big trees, such tree-houses, reached by ladders, giving them safety against intruders, human or animal.

The **taming and rearing of animals** was a great advance and greatly influenced life and occupations. Hunting was precarious and attended with dangers; to take captured animals was not easy; but to carry home the young of animals that were slain was easier and more profitable. Animals were necessary not only for supplying man with food or facilities for transport, but also for providing him with useful forms of clothing. The rearing of animals became thus an important occupation.

In course of time, **agriculture and cattle-breeding** became the principal occupations of man, provided him with the means of living and exercised considerable influence upon him and his life. Agriculture did not at first lead to settled habitation; the exhaustion of the soil, by continued harvesting without manuring, time after time drove man to new fields. But with the growth of population, the improvement of houses and increase of possessions, frequent movement in search of fresh lands was not readily practicable. A wandering existence was replaced by a more settled life; extensive agriculture gave place to intensive cultivation.

Unsettled life among nomadic people retards development both in pace and degree, and few occupations besides cattle-rearing assume importance. Forms of government remain tribal—simple and homely. Settled habitation therefore marked a very important stage in the development of human life. Isolation gave place to intercourse among families which learnt to assist one another. Co-operation for the satisfaction of common needs led to the organization of society and government and specialization in **arts and crafts.** Instead of every farmer carrying on different trades, arts and crafts for himself during his leisure, division of labour was introduced, and those developing special skill in a particular trade began to specialize in that trade for the benefit of the community, in return for payments in kind made by other members of the body.

The development of different trades and crafts which led to the **interchange of goods** constitutes a marked advance in the evolution and differentiation of human occupations. Barter was found unsatisfactory, as the craftsman could not necessarily satisfy his needs in time or in quality. This difficulty led to the adoption of a **medium of exchange** and the advent of money economy. It now became easy enough to buy and sell; **markets** were established, and **trade** was added to agriculture, cattle-rearing and crafts as an important occupation. Exchange of surplus and special products between neighbouring villages or settlements brought about an increase in trade; advantageous situation favoured some of these settlements and made them recognized market places.

The occupations of man thus developed gradually from the earliest times, when man merely hunted, fished and gathered vegetable food. This stage led to primitive agriculture, and this was followed by cattle-breeding and stock-raising, agriculture, crafts or manufactures and trade. The great development of the means of communication and transport from the use of certain animals as beasts of burden, to the harnessing of steam and electricity to the service of man, has led to great progress by enabling division of labour not only between man and man, but between countries in the different parts of the world, and family or household economy has been replaced by international and world-wide economy.

4. ANCIENT HINDU IDEAS ABOUT MAN AND HIS PROGRESS

Hindu scriptures are a rich mine of information, and much useful knowledge of the world of the early days when they were composed can be gleaned from them. It is no use discarding the geography of the Puranas or the story of the Creation of the world, and dismissing them as fantastic creations of the brain. The better course is to try to divest it as far as possible of the allegorical envelope and bring out the underlying facts.

The learned rishis of old in composing these Puranas prepared, as it were, a many-sided mirror, each side revealing a different picture. As religion, the loves and amours of the gods, their fights and hates have to be accepted with faith and without question. Rationally, these are capable of very different explanations. The historian might find in these tales the progress of the Aryans in the Ganges basin, continual fights of the gods with the demons being the fights between the Aryans, supported by their gods led by Indra, and the aboriginal races, who kept up a continuous struggle against the advancing Aryans.

Nor is the story of the Creation pure imagination and fancy. Studied carefully, and divested of all allegorical symbolism, the tale corresponds very closely to what modern science has to tell us in this respect. How the world was at first a blazing globe, how it came to be covered with the hydrosphere and invested with an atmosphere, how the first hot rain fell, are facts related in the Puranas no less clearly than in the theories of Laplace and others. Even the story of **Sheshashayi Bhagwan** and the lotus flower coming up on the surface from his navel, how the lotus opened and Brahma saw the light of day, signifies how the world was at one time covered over with oceans, and how dry land gradually emerged therefrom as an island.

Dashavatar. The story of the Creation as revealed in the Hindu scriptures is not at all fantastic, but agrees well with modern theories on the subject. The story of the progress of the world since creation is also continued further in the stories about the **Dashavatar** or the ten incarnations of Vishnu. There is no doubt whatever that the ten **avatars,** whatever else they might signify, unfold the principal landmarks in the evolution of man, and his subsequent progress.

The Matsya avatar and the age of fishes. The great river plains of northern India, the later home of the early Aryans, were once beneath the surface of a great sea. In the deep seas we see a great variety of life-forms, developing in various ways. In the Devonian age of the palaeozoic era, the first vertebrate animal - the fish—was evolved, and this age is called by modern geologists the age of fishes. The fish represents a distinct advance in structure over the animal forms of preceding periods, and well constitutes a landmark in geological history. The Aryans instead of designating this period the age of fishes have chosen poetically to call it the **Matsya avatar,** the incarnation of Vishnu in the shape of a big fish. The incidents and achievements of this avatar merely describe the conditions of life that prevailed in that age as imagined by the scientist-sage. The fish was the highest type of life-form so far evolved ; and as inferior forms still remained, it might well be called an incarnation of God.

The Kurma avatar and the age of amphibians. The seas and lakes of the Devonian period swarmed with gigantic fishes, some toothed and armour-plated, some covered with scales, others having both gills and lungs. From the last were evolved the amphibians. It was towards the end of the permo-carboniferous, or the Gondwana, age that we find the Indo-African continent gradually vanishing, and the Rajputana Sea along with the Tethys receding and shrinking. Islands began to make their appearance, and the change from water alone, to water and land, was accompanied by the appearance of the amphibians distinguished by the Aryans as the **Kurma avatar** or the turtle incarnation.

The Varaha avatar and the evolution of land animals. The mesozoic strata unfold to us new and wonderful forms of life, giant reptiles swarm in the sea, in the air and over the land. Birds appear and so do the first mammals. The jurassic age was the age of reptiles, a phenomenon which does not, however, seem to have been accepted by the Aryans as sufficiently distinctive to be commemorated as an avatar. Thereafter great changes took place in India ; the peninsular part, hitherto connected with south-eastern Africa, was now linked with the northern by the uplift of the low flat plains, and in the miocene period in the cainozoic age the giant Himalayas were uplifted. The definite emergence of dry land in the home of the Aryans, where naturally their geological studies must have been pursued, meant the appearance of new types of animals which could live on land only. The boar represented the highest type and was elevated into the **Varaha avatar** or the boar incarnation.

The Narsinha avatar and the highest development of animals. At first the mammals were more like kangaroos, that is, marsupials ; then the higher and more familiar forms were developed. The lion represents practically the last word among beasts. The combination of energy and valour, strength and sagacity places it above all the other animals. It is easy, therefore, to understand the evolution of this type, the lion, as an avatar, the **Narsinha,** the man-lion, half man, half beast.

The Waman avatar and the coming of man. The last period of the tertiary times witnesses the appearance of a new type of being. Man, the highest product of evolution, comes upon the scene. One great quality, however, distinguished man from the lower creatures : he was endowed with **reason.** This new characteristic of animal life is perhaps most emphasized in the story of the **Waman avatar.** Waman, a dwarf-Brahmin, a typical creature weak in body but strong in skill, overthrows King Bali the strong, a representative of brute force, not in a fight where strength and energy count, but by outwitting him. The story merely illustrates the rise of a new factor in the conquest and control of the world. The leadership of the world would go henceforth to him who could, if necessary, outwit his antagonists. For mere physical strength, there is no place in heaven or earth, but only in **patal,** the antipodes of man's habitation, whither Bali was pressed down by the third step of Waman. The **Waman avatar** thus commemorates a great landmark, the birth of man and of reason.

Parasuram and the spirit of association. Man now considers himself monarch of all he surveys. In those early days, perhaps 500,000 years ago, he seems to have been the wretched slave of his surroundings. His wretchedness lay chiefly in his many dangers. Self-preservation was the predominant idea, and everything else centred round it. He was therefore a destructive being, destroying, by strength or skill or both, the animals who furnished him with food, the animals who were a positive danger to his safety, as well as the men who tried to snatch from him the food he had laboriously gathered, or who perhaps tried to make a meal of him. There would be no feeling of humanity, brotherhood or sociability in those times when man lived and slept with death at his elbow. It is no wonder, then, that he became a malicious, crafty, fierce, destructive animal. But when this goes on for a long time, a new tendency gradually arises; a new desire, to live at peace rather than be at perpetual war with his fellow beings, comes into existence. As the later Aryan terminology assigned the work of destruction of enemies to the class of **Kshatriyas,** the new stage may be fitly called the **anti-Kshatriya** spirit. This then was the mission of **Parasuram,** the sixth avatar, which seems to parallel that of King Arthur and his Knights of the Round Table—to clear the beast-ridden land and to humanize man. Incidentally we also mark with Parasuram the advent of the Metal Age in India from his weapon, the mace.

Rama and the formation of society and the state. With the accomplishment of Parasuram's mission, man was prepared to form social groups each inhabiting a distinct area, thus forming villages and towns. Isolation, however, then as now, was better for contemplation and the advancement of learning, and accordingly we find sages, the great **rishis** and **munis** staying with their pupils in **ashramas** on the riverside or in forest. The age of **Rama** to some extent overlaps the age of Parasuram; the two avatars are represented as having co-existed for a time. This is quite intelligible since the spirit of association being once evolved, society and the state soon follow. Here first, practically, we hear of a city state governed by a military class of Kshatriyas assisted by ministers drawn from the aristocracy of learning, the Brahmins. The incidents in the Ramayana reveal a very primitive type of society. Towns are evidently few and far between and forest life does not seem to dismay even the tender Sita. In the forests, the brothers and Sita lived in primitive fashion, hunting and gathering fruits and roots for food; their dress, too, was evidently made of barks and leaves. Sita's desire to have a bodice made of the skin of the enchanted gold-coloured deer also bespeaks the primitiveness of the age. Evidently forest life was not quite a thing of the past even then, and society and the state were yet in their infancy. Of course, there is a very decided advance on the preceding age, the age of Parasuram. Whereas the Waman avatar signified the advent of reason and stratagem as the golden keys to success, and Parasuram the spirit of association and the end of isolation, forest life and destructivism, the Rama avatar stands for society and the state, the spirit of co-operation. It is no longer the beast that man is afraid of; it is rather the reactionary or the being in the lower stage of civilization who is an obstacle to progress.

The Krishna avatar, first phase, and the pastoral age. In the evolution of the natural occupations of man, the pastoral age succeeds the forest age. The transition from hunting wild animals to the breeding and rearing of certain herbivorous ones marks a great advance in the history of mankind. Pastoral work demands for success the constant co-operation of many persons, and so leads to the adoption of a closely-knit tribal organization which again paves the way to higher social and political communities. The life must, however, be migratory, and this limits the acquisition of property except in the form of flocks and herds which sometimes become very large. The story of the exploits of **Krishna** and the manner of his life reveal the pastoral age. Large herds of cattle are constantly referred to, and the youth of Krishna is passed in the company of cow-boys and milkmaids. But with the destruction of Krishna's demon uncle Kansa, the picture changes; and, soon after, the scene too changes. From Mathura on the Jumna the scene shifts to Dwarka on the north-western extremity of the Kathiawar peninsula. The pastoral age is transmogrified into an advanced age of society. Evidently there is a gap in the story. The Gopis with Radha, Nanda and Yashoda, and the familiar figures of the pastoral age all vanish and the simplicity of the earlier age is rudely replaced by the complexities of an advanced one, in which we clearly see the glimmerings of the characteristic features of modern society and state. Balarama, the elder brother of Krishna, with his primitive weapon—the quarterstaff—seems to be the more consistent representative of the pastoral age than Krishna, the King of Dwarka. The Krishna avatar thus seems to be two distinct epochs each marking a stage in the progress of man, presented side by side as one continuous whole. It seems that there were two Krishnas—the Krishna of the milkmaids and the Krishna of the Mahabharata.

The Krishna avatar, second phase, and the age of organization. That there was a very considerable advance all round, in this age, is very clear. The conditions more nearly approximate to those within historic times in India under Hindu rule. The royal princes not only won their spurs, as in the Ramayana, but were systematically trained in a special school under a great military expert. The weapons in use now became much more advanced than in the preceding ages. Archery was still predominant and reached great perfection. There was of course the mighty Bhima with his terrible club ; but in Arjuna, the friend and brother-in-law of Krishna of Dwarka, we find the perfect archer, the sharp-shooter *par excellence*, to whom mere sound was enough to direct the death-dealing dart. The advance, however, did not stop at this ; the **mantras** made the arrows perform all imaginable things. There is clear evidence of the great progress achieved in the character and use of weapons. The period of the exile of the Pandavas was spent not wholly in the forests, as in the Ramayana, but in towns and villages, a fact which clearly reveals that society had emerged into the agricultural and manufacturing stages from the primitive types of the earlier periods. But more than this ; it is generalship that spells success in warfare, and not merely individual skill or prowess, much less mere physical strength. On the occasion of the Kauravas' raid in Virata, it was the Pandava leadership that brought the victory.

Again on the eve of the great war, Arjuna and Duryodhana, the Kaurava leader, sought an alliance with the great Dwarka king Krishna. Being unwilling to displease either side, Krishna proposed to lend his forces to one side and himself as a non-combatant to the other. Duryodhana, who was offered the choice, foolishly preferred to choose the army, and lost; Arjuna had the general, and won. The advent of the generalissimo implies high development of military tactics and strategy.

The state appears, in this age, to have been well organized. The rather democratic tribal chiefship or urban kingship had been replaced by an absolute monarchy; the monarch was assisted, and often guided and controlled, by a council of princes, sirdars, notables and feudatories; while ambassadors, and diplomacy too, had a place.

The Buddha avatar and the age of enlightenment. The last age saw practically all the characteristic features of the modern society and the modern state more or less developed. Naturally, there had been wonderful progress in each department since. But the direction of progress had not been so distinctive as to constitute a landmark and an avatar. The development of the spiritual side of man's nature, the enlightenment of his inner self, brought about by deep concentration and meditation, and the evolution of the softer graces of humanity were yet to come. This great stage was ushered in by Bhagwan Buddha, the enlightened; and as heroic adventures cannot fit in with the struggles in the inner man, we have no great epic, weaving scientific evolution and fiction in a soul-absorbing story. The new teaching is promulgated to the world as a great religion—Buddhism. Sinless life, effacement of self, development of soul-force, mercy, justice, humanity and universal brotherhood are the ideals of the new age.

The Kalki avatar and the passing of man. These new ideals have been preached and accepted in theory, but practised in the spirit of the great master by very few. We are yet passing through the Buddha epoch; no new avatar can be expected till we all become practically so many Buddhas, more or less. What the new epoch will be, it is impossible to say, with our human limitations of forecasting and thinking about the future. But this much can be said: that with the progress of man, in material organization and spiritual organization, from the days of Waman to the end of the Buddha age, man will have attained the highest limit of excellence or perfection, and nothing else can possibly remain but the evolution perhaps of an altogether new type of being, differing as radically from man as man differed from beast; or, if the Creator does not wish to create a new type of being, nothing else remains but the end of the world; and this is believed to be the mission of the next avatar of the future, the **Kalki.**

The present age then is that of Buddha; but it must be remembered that the evolution of a superior type does not connote the absolute extinction of the current one. The latter will certainly sink into insignificance more and more as the former spreads; but till then, and even thereafter, it will be possible to find specimens of most epochs still in existence. There are numerous marine animals, numerous amphibians, numerous land animals from the boar to the lion, numerous men still in the primitive stages of culture; but in the mass we of the present day belong largely to the Krishna stage with the characteristics in some cases more or less developed and emphasized. Only a few of us belong to the new epoch heralded by Buddha; these few, the moment their Buddha stage comes into prominence, immediately subdue the many still lagging behind in the bygone stages, not by force or stratagem, but by enlightenment; and these few exercise great influence over the wide world and have their superiority promptly acknowledged.

Besides these great or major incarnations, there are many more which are regarded as minor incarnations, and these also on examination and analysis, stand revealed as the minor stages through which the main stages in the history of the evolution and progress of man have been attained.

5. PROGRESS AND CIVILIZATION

It is interesting to trace the geographical background of the slow yet steady, silent yet resistless, march of civilization and world power throughout the ages from the east to the west. The westward movement has been a conspicuous feature of the history of civilization, in spite of occasional set-backs on account of the lagging east contesting the place of honour.

The great stages of human progress and civilization are four :

(i) The fluvial stage of the alluvial river valleys.
(ii) The inland sea stage.
(iii) The Atlantic stage.
(iv) The Pacific stage.

The fluvial stage. Archaeological and other evidences have not yet been able to establish definitely the starting point of civilization, and while many European scholars see it in Egypt, the claims of China and India cannot be ignored. Early civilization required for its growth three conditions above all—a suitable climate, peace and security, and easy production and transport. Excluding the tropical and the polar regions as being obviously unsuitable for the developments of early civilizations, and excluding the cool temperate zone also as being less suitable on account of a harder struggle being required of man against nature, the sub-tropical regions, or roughly regions between latitude 25° and 50°, stand out clearly as the centres of early civilization. River basins provide fertile soils and easy transport in small boats, and where they are well protected against outside aggression, as in the case of the Yangtze-Kiang, the Ganges, and the Mesopotamian rivers, by high and lofty mountain ranges, they are well fitted to afford man facilities to evolve civilization and achieve great control over nature and over neighbours less fortunately situated, and attain a measure of world-power. Primitive methods of transport in early times did not permit any considerable intercourse, and this fluvial stage saw isolated centres of civilization, reaching a very high level indeed, co-existing with undeveloped regions close by.

Such river-valley civilization was achieved in very ancient times in China. The basin of the Hwang Ho was probably the earliest region to develop, but the frequent floods and the shifting of the river-bed drove the people southwards to the valley of another great river in China, the **Yangtze-Kiang.** Here the progress was great and man developed early. The people not only carried on advanced agriculture, but they also developed commerce with neighbouring regions. The westward movement from the western shores of the Pacific—China, the Celestial Kingdom—to the evolution of the Hindu civilization on the banks of the Ganges, was, however, an extremely slow process.

Bands of nomadic people wandered from the northern regions to the valley of the **Indus,** spread all over the Punjab and penetrated gradually into the valley of the **Ganges** as far as Bengal. The people were herdsmen, with their flocks and herds ; but under the stimulus of favourable conditions they developed agriculture and settled down in villages and towns, so that the Ganges valley developed into a region of large cities, and the Hindu civilization reached a very high level indeed. Thence, equally slowly, the westward march continued to the fair fields of Mesopotamia and the banks of the Nile.

The **Babylonian** civilization in the basins of the **Euphrates** and **Tigris** developed a dense population not merely agricultural; industries and trade also flourished, weaving became important and Babylonia became a great commercial region. A competitor, the Assyrian empire, arose in the Tigris basin and gathered strength and power enough to absorb the whole of Babylonia. It was, however, later overthrown, and the Babylonian civilization reasserted itself. The valley of the two rivers long continued to attract invader after invader, as did the valleys of the Indus and the Ganges. Later, the region entered upon a long period of stagnation, retrogression and decay as a result of increasing desiccation and neglected irrigation.

The **Nile valley** is well known as one of the earliest centres of civilization. Separated from other centres by the desert, Egyptian culture assumed a distinctive character, and inscriptions and artistic products furnish us with the means of obtaining a complete history of the progress of man in that river basin. The isolation of Egypt was, however, not complete ; intercourse with Babylonia on the one hand, and with south-eastern Europe on the other, was close enough to permit interchange of ideas, exchange of products and the development of a high order of civilization. The civilizations of China, India, Mesopotamia and Egypt are not only the most significant from the point of view of ancient culture, but also because they have left permanent impressions on the development of mankind. Each river valley developed a distinctive type of civilization, and achieved considerable progress before outside influences began to penetrate it. The high level which these ancient civilizations attained is shown by the fact that many principles, ideas and ideals then evolved remain apparently unchanged even now.

The inland sea stage. Here, at last, new geographical conditions presented themselves, and there was a new orientation of civilization, the river basin ceasing to be of primary importance. The vast land-locked Mediterranean was now opened to view. Between the Egyptian and Mesopotamian centres, where the Assyrians and the Babylonians had successively established centres of power and progress, there was intercourse by land, through the districts on the shores of the Levant; and the **Phoenicians,** the people of this region, received an impetus and led the way to the second stage of civilization—the **inland sea stage.** As carriers between the two great river basins, they imbibed the spirit of commerce and trade, and gave to civilization a commercial touch. The Phoenicians navigated the Mediterranean, and are believed to have passed out from that mid-world sea and even reached the shores of the 'tin islands', as Britain was then known because of the tin mines of Cornwall.

From them, the torch passed on to **Greece,** which in harmony with its mountains and valleys, developed under the city states of Athens and Sparta, power and progress, which gave it supremacy and the leadership of the world. Meanwhile the plateau of Persia developed in its inhabitants a civilization of a high order, resulting in a conflict with Greece, which ended in the triumph of the younger and rising Greece over the hordes of Persia. Greece established colonies in the little islands and coasts of the Mediterranean and even on the Black Sea coasts. Under Alexander, the eastern Mediterranean countries were welded into one empire. Western Asia and even the borders of India for a time came under his influence. The culture of the Mediterranean spread through Greece to the whole of the then-known world, and Hellenic influence permeated the whole current of life and thought in the East, even as far as China and Japan.

Greece remained in the van of civilization for a long time till a commercial civilization, like that of the Phoenicians, sprang up on the African shores in **Carthage** (now known as Tunis). From their little base, they succeeded in establishing control along the northern shores of Africa and also over the Spanish peninsula. Meanwhile a new power was rising in **Rome** on the banks of the Tiber. Rome wrested the premier place from Greece and Carthage after a long and arduous struggle. Rome remained the centre of the civilized world for many centuries, and became the mistress of the world. Spain, France, and Britain all came under her sway, as did western Asia, southern Europe and northern Africa. The Romans gave to the world the art of road-making, a sound system of jurisprudence and a fine system of government of a vast empire. The central situation of Italy, in the mid-world ocean, enabled the Roman Empire to hold its position as the predominant world power for a long period of time.

The desert lands of **Arabia,** left aside by the westward march of civilization, were now affected by it, and the followers of Mohammed, the Prophet of Islam, spread rapidly along the northern shore of Africa and revitalized the plateaux of Persia and the steppelands of Turan ; so that while the Roman Empire declined, fell and disintegrated, Islamic culture represented the standard of light and learning. The crusades, and later on the incursions of Changhiz Khan and Tamerlane, and the Ottoman conquest of Constantinople represent the struggles of the East with the western movement, the issue of which has always been, in spite of temporary set-backs, in favour of the West. With the occupation of Spain by the Moors, Islam had reached its westernmost limits, and their expulsion from there under Ferdinand and Isabella, and the subsequent geographical discoveries ushered in the third stage—the **Atlantic stage**—of civilization.

Italian sea-towns had during the dark and the middle ages carried on the trade between the rich East and the progressing West, Venice establishing its importance in Greece and Syria, and Genoa and Pisa in Asia Minor and the Black and Caspian seas. Transalpine lands were made accessible by the opening up of trade routes from Milan and Turin across the Alpine passes. With the dawn of the age of exploration the Mediterranean gradually declined in importance and ceased to be the centre of world power and civilization and Venice and Genoa became shadows of their former selves. The West attracted attention and western ports rose rapidly into prominence.

It was, however, not only on the shores of the Mediterranean Sea that civilization developed rapidly; other inland seas witnessed a similar progress. The Baltic Sea rose into importance, and the countries bordering it made their mark as centres of light and power, Denmark becoming the most extensive kingdom in northern Europe. The Hanseatic League, the rise of Flanders and the commencement of the third stage of civilization, that of the Atlantic, all contributed to the decline of the Baltic circle of civilization. Similarly in North America, the Gulf of Mexico saw the rise of a remarkable civilization, during this period, in its islands and the peninsula of Yucatan. The Mayas were great pyramid-builders; and though they were backward in several respects, there is evidence to show that they had developed their calendar and hieroglyphic writing.

The Atlantic stage. With the advent of the third phase of civilization, that of the Atlantic shores, **Spain** rose to power, and the riches of the Americas made Spain, under Philip and Charles, the herald of the new oceanic civilization. Sea power, colonial expansion and commercial development became the objectives in the new age, and western European countries found themselves in a central situation bordering on the Atlantic. Oceans ceased to be barriers and became the highways of commerce. From Spain, **France** caught the flame, attaining the height of her power under Louis XIV. The little islands in the north-western corner of Europe, the British Isles, soon became the centre of the land hemisphere and, wresting the carrying trade of the world from the Netherlanders, embarked on a contest for world power with France. The Seven Years' War decided the issue in favour of Britain, and though the loss of the American colonies and the rise of Napoleon were set-backs, **Britain** thenceforth stood out unmistakably as the centre of world power and civilization, building up a huge colonial empire based on commerce, which from being local and continental now became world-wide and international. The mechanical inventions towards the close of the eighteenth century secured to Britain the first place in industries, transport and trade.

The Pacific stage. The present century has seen the lead passing to the other shores of the Atlantic, so that while Europe remains a highly civilized and powerful land, increased importance has accrued to **America**, especially the United States, which has been securing increasingly a front place in the councils of the world. This country, with its big business, inventiveness and labour-saving devices, has evolved an industrial civilization of a high order. The northern plains of Europe, Germany and the forest lands, Russia, left out in the dark for so long, have been roused, and enter the arena for world supremacy and power; but the westward movement seems irresistible; even in America, the centre of population has been steadily moving westwards, and the Pacific shores of the United States are claiming an increasing measure of importance. It seems as if the Atlantic stage is ending and a new age is dawning--that of the Pacific. The great world problems are focusing on the opposite shores of that vast ocean. **Japan** has seen the dawn of a new light and there are indications of awakening even farther westward. Indeed, America, the Great West, is becoming the Far East; and the Far East of today, Japan and China, are becoming the Far West for America. This latest phase has been ushered in by the colonization of Australia and New Zealand, the westernization and modernization of Japan, the commercial penetration into China, and the connecting up of the east and the west of North America by the great newly-built transcontinental railways and the Panama Canal.

The four stages. The river basin as a centre for civilization thus yielded its position of pre-eminence to the large inland sea; this in its turn yielded to the lesser ocean, and the Atlantic is yielding to the broader Pacific. The isolation of the early civilization gave place to increased intercourse between nations in the Mediterranean stage; this became easier and more extensive in the Atlantic stage and is becoming world-wide in the Pacific stage. The river boat was displaced by the sailing vessel, this by the steamship, which is fast losing some of its pre-eminence before aerial navigation. The fluvial stage was essentially based on land power, the Mediterranean stage on land power supplemented by sea power, and the Atlantic on sea power, while the coming Pacific stage is dominated by sea power supplemented by air power. Larger and larger areas are welded into groups by the dominant power in each succeeding phase. The small unit of the river basin expanded into the mid-world area dominated by Rome; this was far exceeded by the extensive and far-flung areas constituting the British Empire. And now the whole world is striving to achieve a measure of homogeneity and unification under the League of Nations, which although falling short of its ideals, represents a noble conception, the natural accompaniment of the world stage of civilization which is being ushered in by development of the Pacific countries. Development from the isolated individual to the tribe, the state, the small empire, the vast colonial empire and the wide world is the striking achievement of civilization, which has been steadily restricting the sphere of competition and extending the sphere of co-operation. Intense nationalism is but a phase in the onward march of civilization, which, when it has served its purpose of raising backward peoples, will enable international co-operation to be a reality instead of being merely an objective. The play of geographical factors is easily discernible in this progress of civilization westwards; but it is not clear why these factors should have been so shaped that the progression is from east to west and that the call is ever westward.

6. POPULATION AND POPULATION MOVEMENTS

The population of the world is about 2,060,000,000. But these people are not found uniformly distributed over the land surface. In some areas, there is much greater concentration; in some there is practically no population at all. The density of population differs in different parts of the world and is spoken of as so many persons per square mile. It is usual to regard 200 persons to the square mile as a dense population and less than 50 persons as sparse. Maps of the

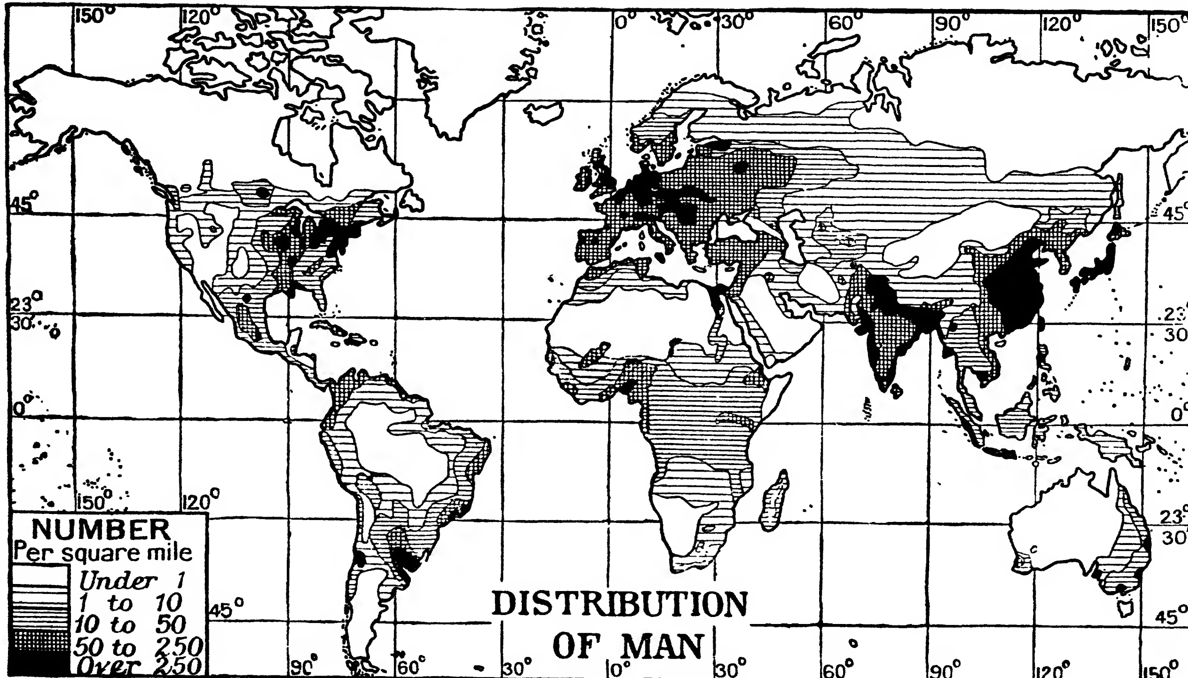

FIG. 84. Density of population

world showing the density of population divide areas by lines of equal density, and the different degrees of density are usually grouped into classes, such as, under 10, 10-50, 50-100, 100-200, 200-400, and over 400 persons to the square mile. Sometimes the limits of the classes are expressed as powers of 2 and the classes in that case would be: under 32, 32-64, 64-128, 128-256, 256-512, and over 512.

Density of population. The concentration of population in definite areas clearly depends primarily upon the productivity of these areas, which lightens the struggle for existence, and upon their easy accessibility and freedom of movement. The polar and equatorial regions, the tropical and sub-tropical deserts and mountain regions are, with exceptions, of little importance, as they are incapable of attracting and supporting a dense population. People thus tend to become concentrated in the great fertile lowland plains of the world in the tropical, sub-tropical and temperate regions, where advanced agriculture can maintain large populations. Agriculture depends on rainfall, its amount and seasonal distribution, and the density of population in a region is therefore closely associated with the distribution of rainfall there. The heavier the rainfall, and the more even its distribution throughout the year, the greater is the productivity of agricultural lands and the denser the population supported by them. Consequently, river basins in general are great centres of population; and the basins of the Yangtze-Kiang and Ganges maintain huge populations, where heavy summer rains and high temperature permit of agriculture being intensive. Java is another region, always hot and moist, with a dense population. Excessive rainfall, however, becomes a handicap; and the forests of the Amazon, large tracts of which are uninhabited, contrast with those of the Congo, where primitive agriculture maintains a moderate population in forest clearings. The absence of rain makes uninhabitable such arid regions as the great deserts of north Africa, Arabia, and Australia, and some portions of the dry interior plains of Asia and North America, while an extremely cold climate keeps the population scanty in the extensive coniferous forests and tundras of the north. To make up for deficiency of rainfall, irrigation is being increasingly extended, and extensive irrigation leads to a fairly high density of population. The Nile valley is a densely peopled area on this account ; the middle and lower valleys of the Indus have also reacted to the extensive facilities for irrigation provided in the Punjab and Sind by a large increase in population ; and under similar conditions, Iraq, South Africa and Australia show promise of denser populations.

Western Europe and the Atlantic coasts of North America have also dense populations, but agricultural productivity is not the main cause of the density. Industries and trade characteristic of the western type of civilization have been established there and attract and maintain large populations.

Among the areas not yet densely peopled, but which seem capable of supporting much larger numbers than they do at present, may be mentioned the north Eurasian belt on the southern borders of the coniferous forests and the temperate grasslands, and the similar belt across Canada. This latter is developing fast, and the population is rapidly increasing.

Regions of the Mediterranean type in the two Americas, southern Africa and Australia also offer great possibilities, and so do the eastern sub-tropical margins in the southern continents like east Africa, south-east Australia and the Plate river basin in South America.

While the natural productivity, agricultural, mineral, or industrial, is the basis of population concentration, the present distribution of the world's population does not necessarily agree with the theoretically possible distribution. Natural obstacles like the Himalayas and other mountain barriers on the north of India and the high Andes in South America make access to good regions difficult ; while artificial barriers like the restrictive immigration laws of various countries prevent the free flow of people, thus retarding the adjustment of the world's population to the available food-supply of different regions. Further, the tendency of people to cling to their original homeland, human inertia, is another obstacle to this process of adjustment of populations to food-supply. All such barriers present to the world the curious spectacle of over-population in lands like India and China co-existing with under-population in the newer lands of America, Africa and Australasia where the natural resources are vast, but still almost unexploited.

Migrations. The peoples of the world have, however, never been stationary; from the earliest times population movements have been going on, and every country has received at one time or another diverse streams of humanity. India has received various intruding peoples from the Aryan invasion to the present day; Great Britain, though an island, has received different streams from the days of the Romans to the recent immigration of the Russian and German Jews, and Egypt and Iraq have similar tales to unfold. All such movements have been inspired by the pressure of an overgrown population on the local resources, and the spirit of aggression demanding additional resources from neighbouring lands. Raids followed in an effort to despoil prosperous and fertile regions of their riches or share these with the people there.

Among primitive peoples, such movements are simple, the migrations involving whole tribes; but among civilized peoples, they are more complex and the various classes of society are differently affected. External expansion is directed by aggressive frontiersmen and armies of invasion, assisted by bands of adventurers and explorers, enterprising merchants, settlers and missionaries, who thus keep up a constant movement among the people, while the bulk of the population concentrates its force on intensive internal development. With the widening of the national area, the geographical horizon is extended and a great mobility is evolved, within and without, attaching, however, to certain classes of society only. This mobility is the visible consequence of wants, needs and ambitions, economic, intellectual and political, and leads to the building up of great empires, the development of new lands by colonization, increased world-wide intercourse, commercial and intellectual, and the attainment of a higher level of civilization.

The mobility of primitive peoples is checked and hampered by the usual barriers of mountains, deserts, seas and forests; but their restricted geographical outlook has been a further obstacle. Ignorance limits human desires; expansion of the geographical horizon quickens the desire for further expansion and sets in motion further movements. Trade during the middle ages by the overland, Persian Gulf and Red

Sea routes had established a familiarity between Europe and the East. But the full historical and geographical importance of this trade is perceived when we remember that it spurred on the great geographical discoveries of the fifteenth century. The consequent expansion of the horizon to embrace the whole known world, started a widespread movement resulting in the spread of European culture all over the world. Civilized man is, in a sense, less mobile than primitive man. Advancing civilization creates greater and greater bonds which tie him down to the soil and the home, and tends to curb and control his desire for migration and movement. On the other hand at the same time, it increases the facilities for movements by forest clearance, the construction of bridges, road-building, and the introduction of swifter modes of transport.

Where the conquered people far outnumber the conquerors and cannot therefore be exterminated, expelled or dislodged, the visitors and their civilization are bound to be eventually absorbed by the indigenous population, for example, the Normans in England, the Lombards in Italy and the Moguls in India. But where the superiority in culture lies markedly with the intruding peoples, the religion, language, customs and methods of the conquerors gradually permeate into the life of the conquered. Thus was ancient India Aryanized and modern India Anglicized; thus was the Levant Hellenized, and the whole eastern and southern sides of the Mediterranean from Syria to Spain Arabianized by the Saracens; thus were Mexico and Peru and indeed the whole of Central and South America, Latinized.

Migrations, great and small, bring about a great deal of intermixture of races and civilizations. Great historical movements have often been preceded by raids, invasions and piratical intrusions. These lead to the expansion of the geographical horizon, which brings about reinforcements from the home to assist the intruders who settle down permanently. Thus migration takes place on a large scale with the inevitable ethnic intermixture. This was what happened in the case of the invasions of India by Mahmud of Ghazni and the foundation of the Mohammedan kingdoms in Delhi, and the later incursions of Timur, resulting in the establishment of the Mogul Empire in India. Such movements of savage and pastoral peoples lead to desolation, brought about by killing or enslavement of prisoners and the flight of the conquered people, and exercise profound influences by leading to an intermingling of races and the blending of civilization. In Africa, slavery was looked upon as a source of wealth in connexion with agriculture, and the slave trade with other continents became a feature of international trade. This trade derives its chief importance today in that it has created a **Negro problem** in the United States of America and has led to the peoples of Venezuela and Brazil having a broad negro strain, for the total numbers involved in these slave migrations were larger than those concerned in many other movements, such as the Ottoman invasion of Europe.

Colonization. With a settled and sedentary life and the advance of civilization, population increases, means of communication improve and the geographical horizon expands. These conditions give an impetus to migrations for settlement and colonization, which have been so characteristic of commercial peoples in all times, ancient and modern. Emigration involves, to start with, only individuals and groups; but in course of time, the numbers concerned often become large. Four million Irish have thus emigrated to other lands in the course of the last hundred years; at least five million Germans have settled in different parts of the world outside Europe since the Napoleonic Wars; and even Indians overseas number about two and a half million. Colonization is indeed the most powerful and significant instrument of national expansion, so that it has changed completely the relative positions of nations. Thus England has been elevated to the leadership of the world, Spain and Portugal were raised to a position of world-wide importance for a couple of centuries, Holland pulsated with new life and activity, Russia became a great world power. Germany and Italy, however, achieved their unity comparatively very late, and when they turned to colonization, they found but few desirable lands left, and it is this circumstance that forms the background of the complications of European politics today.

Extensive population movements are often stimulated by **commerce** which is the spur underlying colonization. The explorer widens the geographical horizon; the trader steps in and is followed by the settler and the soldier, so that the flag follows the trade. It was thus the fur traders who paved the way for French colonization in the western provinces of Canada, and led the advance of the Russians across the plains of northern Asia. The caravan trade routes between China and the Black Sea promoted the Asiatic incursions into Europe; the caravan trade across the Sahara from the Mediterranean to the Guinea coast gave to Prince Henry the Navigator the idea of a sea route to that coast, an idea which culminated in the Portuguese discovery of the route round the Cape of Good Hope, and the establishment of European trading settlements in India and the ultimate evolution of British rule there.

Religion is another important factor that directs, controls and stimulates large population movements. **Pilgrimages** are concerned with large numbers drawn from many lands, distant and near. Pilgrims, in passing through other lands, stimulate trade and contribute to commercial and cultural development by increased intercourse among people of diverse regions. The **Hindu** pilgrimages have contributed universally to the Aryanization of India and the maintenance of a high cultural level. The four cardinal points, Badrinath and Kedarnath, with the Jumnotri and the Gangotri in the north, Rameswaram in the south, Dwarka in the extreme west on the open ocean, and Jagannath Puri on the east dominating the great Indian inland sea, the Bay of Bengal, led to intercourse and movements in all directions, stimulating trade and culture; while Muttra, Allahabad, Benares and Gaya emphasize the importance of the most densely peopled region in India, that of the Ganges valley. In modern times, the religious background is not so strong as hitherto, and pilgrimages in a large measure become tours of sightseeing. With improved means of transport the movements involve very large numbers, but the foci or centres of attraction are no longer the same. The streams of movement flow to Bombay in the west, Calcutta in the east, Madras in the south and the Vale of Kashmir in the north, while the Ganges valley still attracts considerable numbers to its great cities, Delhi, Agra, Cawnpore, and Lucknow. But as Hinduism has been confined to India, the pilgrimages have not contributed to migrations from or to outside areas.

In **Islam**, pilgrimage is considered the duty of every believer, and as the religion has spread west and east to very far-off regions, the annual pilgrimages conducted on a large scale have great commercial importance. About seventy or eighty thousand pilgrims visit Mecca every year; but a far greater number is affected by the pilgrims from all over the whole Mohammedan world, from westernmost Africa to Sin Kiang. Traders join the pilgrims for protection and for profit and the pilgrims themselves take with them herds of cattle to trade on the way. Some merchants drop out and settle in promising lands on the way; others join. The British expedition to Lhasa threw open the markets of western Tibet to Indian merchants, thus bringing these two lands closer to each other; particularly so, as sacred lakes and mountains like Mansarovar and Kailas attract both the pious Hindu and the devout Tibetan Buddhist.

Christian pilgrimages have had still greater importance, intellectual and political. Even in very ancient times Christian pilgrims from Iraq, Persia and India, from Ethiopia and even from distant France and Britain, visited Jerusalem in large numbers. These pilgrimages of the Christians to Jerusalem gave rise to the Crusades, which had such great significance, both economic and cultural. Modern Christian missions too have directly or indirectly, consciously or unconsciously, played and are playing a significant part in the building up of commercial and political power. The Canadian fur trader was accompanied by the Jesuit, and the gold-seeker in Mexico and Peru by the Spanish priest; while the United States owes much to the enterprise and progressive spirit of American missionaries for the possession of the Hawaiian Archipelago. Modern China too regards Christian missions as effective centres for the development of commercial and political influence of European powers.

In modern times, there are organized and conducted tours, and the **tourist traffic** is large enough in some countries to be associated with population movements, inasmuch as, apart from the commercial aspect, such tours have a propagandist effect, and by enlarging the geographical horizon, become the bases of future policies of states. Thus Switzerland is a centre of attraction for the pleasure-seeker and holiday-maker ; England exercises a fascination upon the peoples of the daughter lands and dependencies of the great Empire of which it is the nerve-centre while the Americans spend vast sums of money in touring extensively in Europe and even in India. Tourist travellers are being greatly encouraged by concessional rates offered by shipping companies and by various other methods.

On a smaller scale, **centres of learning** have proved to be centres of attraction, drawing students from distant regions. The influence of this movement has, however, far-reaching significance, for the foreign students imbibe the culture of the land they visit, and are powerful unconscious instruments for the spread of its cultural influence and extension of its commercial importance. Illustrations are provided by the numbers of Indian students who go to British universities, and of Chinese students who attend universities in the United States.

Adherence to zone. A striking fact that is revealed by a study of migrations is the adherence of the migrating people to their own zone and even in some cases to their own parallel of latitude ; migrations beyond the limits of the native zone are restricted in range as well as in the number of people concerned. Settlers are unwilling to face the problem of climatic adaptation unless this is unavoidable, or where superior civilization helps them to surmount the difficulties. China is outside the tropical zone, and yet the Chinese have shown excellent capacity for climatic adaptation. They have pushed southward as far as Singapore, the Philippines, Borneo, Java and Sumatra, all within the tropical zone. The Chinese emigration to California is, however, a movement to a region with similar conditions. The Aryans coming from the warm temperate regions did not quite reach the tropic of Cancer, though their language and culture filtered down to the Deccan and farther south. The principle of adherence to the zone, parallel of latitude or isotherm is also strikingly illustrated by modern colonial movements and race expansions. The English and Irish in the New England States on the Atlantic seaboard, the Scots in Canada, the Germans in the interior near the lake region, the Spaniards in the West Indies and Mexican plateau, the Italians in California and the southern parts of the United States, the Scandinavians in the lake region, the Icelanders in the sub-arctic region north of Winnipeg, all provide excellent examples of movements to lands with similar geographical conditions. Such also are the Russian movements in Siberia, chiefly between the fiftieth and fifty-fifth parallels and the intrusion of the Japanese into Manchukuo, Jehol and northern China. In South America, European, chiefly Italian, immigrants prefer Argentine south of the La Plata and Uruguay, while Venezuela and Colombia have a large Negro population. English immigration into Australia and New Zealand is, however, a change from the cool temperate to rather warm temperate regions. The emigration of south Indians to Ceylon and Malaga, and of Indians farther north to east and south Africa and to Mauritius, to Trinidad and British Guiana also illustrate the same preference for like geographical conditions and adherence to zone or isotherm.

The recent movements of Europeans and Americans into tropical regions whether in Asia, Australasia, Africa or America are not real colonial movements or race expansions ; they aim at **political and commercial exploitation.** New homes are not sought ; it is a search for markets for home manufactures and commercial gain that is the aim, as is illustrated by the British in India, the French in Indo-China, the Dutch in the East Indies and the Americans in the Philippines.

Migrations are also often inspired by the **desire for better land,** a milder climate and easier conditions of life. The incursions of the Mongolians from the Central Asian highlands down to the fertile river plains of China and Turan, the invasions of the pastoral Persians to the agricultural lands of the Indus and Iraq valleys, and the sudden descents of the desert peoples upon the peaceful cultivators of the adjoining prosperous lands have been of this type. A search for a milder climate has been responsible for a steady stream of migration from north to south as well as from east to west. The sunny skies of the Mediterranean lands attracted the people of the bleak Baltic coasts ; the equable and wet western Europe attracted the people of the extreme and dry east. The westward movement receives striking confirmation in the European colonization on the western shores of the Atlantic, the stream spreading ever westward to the Pacific, and in the diffusion of European culture in the Philippines first by Spain and now by the United States. Well has it been said, 'Westward, the star of empire takes its course.' But the star has moved sometimes eastward too. From the highlands of Mongolia the hordes poured down upon the lowlands of China ; conqueror after conqueror has swooped down upon the fertile plains of the Hwang Ho and the well-watered fields of the Yangtze valley, while Russia thwarted in its desire for westward expansion by the strength of the Central European powers, threw out its tentacles eastwards to the Pacific.

We sometimes notice **return movements** when a people, after a long absence from a region which it had once left, returns to it equipped with a higher civilization to exploit its resources. The penetration of the Japanese into Korea and even into Manchukuo and Jehol is such a return movement. Sometimes the return does not signify an advance, but rather a retreat, for example, the backward movement of the Moors from Spain to northern Africa, and the gradual retreat of the Turks from Europe to Asia and of the Tartar tribes to their steppe-lands of central Asia.

Population movements are thus influenced by many factors and differ very widely in purpose and direction, character and the numbers concerned, but they end in **differentiation** and **assimilation.** These are significant stages in the process of evolution, assimilation increasing in importance with time and the growth of population. A great variety of geographical conditions stimulates differentiation, and as the great streams of population movements from Europe have spread over the whole land surface of the globe, differentiation has become marked in the history of various European nations. People like the English, who early displayed a genius for colonization, and the French and Russians who planned and carried out vast territorial expansion, create in their extended territories security for their continued growth and prosperity ; while countries like Germany and Italy, who entered the colonial field very late, have had to be content to have their settlements in unhealthy or barren lands, which do not attract the immigrant and which therefore fail to promote national growth. When population·movements result in the occupation of the land of a relatively backward people, the two types of population co-exist for some time at least, showing marked differentiation in race, conditions of life and localities. Thus castes or classes in India, often marked out by different shades of colour, may be regarded as survivals of ancient ethnic differentiation. Even in Japan, differentiation can be observed in the fact that the high class Japanese are taller and fairer than the lower classes. The native agriculturists in the tropical lands are necessary elements for co-existing with the white peoples, who are not yet acclimatized there. Geographical differentiation is seen in the Red Indians in the United States being confined to reserved areas, and in the coloured people in Kenya being segregated to the lowlands while the highlands are reserved for the whites.

With the increase in the population of the world and improvement in the means of communication, geographical segregation becomes increasingly difficult, differentiation fades and assimilation becomes more significant. The process of assimilation often means slow absorption and welding the differentiated peoples into one. But sometimes it has led in the direction of the extermination of the weaker peoples as in the case of the American Indians and the Australian aborigines. Where, however, climatic conditions are not sufficiently suitable for the conquerors to settle down as genuine colonists as in the case of the Spaniards in Central and South America, the English in India and the Dutch in the East Indies, the process of assimilation is restricted to the spread, all over the acquired territory, of their language, economic methods and culture ; and race differentiation persists.

7. ORIGIN AND GROWTH OF TOWNS

The population of a country or region is usually found very unevenly distributed over the whole area. The need for an assured water-supply leads to clustering of the population on the banks of streams and rivers. Differences in soils is another factor which affects the distribution of population ; the social instinct operates, and clusters of farms form hamlets which grow into villages which in their turn develop into towns. In advanced countries today, this tendency towards clustering in towns is becoming increasingly pronounced, and in India there is a distinct urban movement, people from the villages preferring work in towns and cities to useful toil in the country under definitely healthier conditions. The population thus tends to be dense at different nuclei surrounded by more or less concentric zones of decreasing intensity. The life of the people in the outlying areas is closely interwoven with the life of the town; and with increasing distance from this centre of attraction, the density gradually lessens till the area is caught up by the influence of another nucleus.

Cities, great or small, do not grow up by accident; the site is the result of the influence of fundamental geographical considerations; and it will be clear on examination that the origin and growth of a city are accounted for by the fact that its site possesses the means of satisfying some particular need or needs of man.

For administrative purposes, a **central situation** has always been considered almost vital. But with modern means of communication and transport and with the development of international trade which has converted oceans into highways of commerce, seaports tend to become centres of the economic and perhaps of the political life in the country, and a central situation is not now deemed so necessary. Thus Delhi, the centroid of the triangle joining Bombay, Calcutta and Peshawar, has been the historic capital of north India. The Pandavas in prehistoric times, the Rajput kings like Prithviraj Chauhan, the Afghan Kings and Moguls all ruled from Delhi. The English, coming from overseas, naturally maintained their headquarters at Calcutta for a long time, but ultimately in 1911 the imperial capital was moved to Delhi. The original capital of Russia was Moscow, which is quite central. The lure of westward expansion led to the transfer of the capital to St. Petersburg. But the Russian revolution after the Great War again made Moscow the administrative centre, in a situation more in harmony with the more domestic outlook and eastward ambitions characteristic of the new Government. Most of the historic capitals are thus more or less central. Rome, Vienna and Madrid are further examples. The provincial capitals of India are similarly more or less central, for example, Murshidabad of old Bengal, Patna, Lucknow, Lahore, Nagpur, Hyderabad and Mysore.

Ease of defence and **natural protection** are other important needs of the people. These are afforded by **island sites,** or sites where the town is almost surrounded by water. Thus Srirangam near Trichinopoly is on an island on the Cauvery and has become a sacred town with the well-known and beautiful temple of Vishnu. Paris owes its origin to an island in the Seine. Copenhagen, Venice and Constantinople are other examples more or less of this type. A site isolated by mountains all round and accessible only by narrow passes is also easily defensible, as for example Ajmer, Kabul and Innsbruck. Similarly, oases are valuable from the point of view of natural protection, and Bikaner and Jodhpur in India and Timbuctoo in the Sahara are good examples of towns developing at oases in deserts. An eminence or a hill-top strengthens the defence considerably, and Edinburgh, Quebec, and Athens owe their importance to this factor. In India there have been in history numerous towns of this type like Junagarh in Kathiawar, Pawagarh in the valley of Godhra between Gujarat and Malwa, Gwalior, Asirgarh and the numerous hill forts of Shivaji, such as Sinhgarh and Raigarh, Pratapgarh and Lohgarh. The suffix 'garh' or 'drug' to Indian city names is indicative of this kind of origin.

The **junction of roads and valleys** renders the position an important and central one for trade and for defence. Such sites make nodal towns, which often rise to considerable importance. Numerous instances of such nodal towns can be found in every country, for example, Multan and Peshawar, Nasik and Poona, Bhusawal, Khandwa and Jubbulpore in India; Kashgar and Yarkand in Sin Kiang; Turin and Milan in Italy; London and Leeds and Chester in England; and Vienna, approached from four different directions through gates or passes. Where railways meet, the town grows very greatly in commercial and strategic importance as illustrated by Jubbulpore, Gorakhpur and Ajmer; but the origin of such railway junctions is often to be found in the fact that these are the junctions of natural roads and valleys. Apart from the need for an assured supply of water, accessibility and facilities for agriculture and transport have led to the selection of the site for many **towns on a river.** It is along the banks of a river, big or small, that most towns and villages thus come to be situated.

The exact position on the river where the town grows up has, however, a definite meaning. Thus a wide bend or loop is often chosen for the site of a town as, for example, Agra, where the Jumna turns eastwards, and Paris which lies in a loop of the Seine. Monghyr on the Ganges, Sukkur on the Indus, Goalpara on the Brahmaputra, Mandalay on the Irrawaddy, Chanda on the Penganga (a tributary of the Godavari), Hankow on the Yangtze-Kiang, Budapest on the Danube, Orleans on the Loire, Kazan on the Volga, Cincinnati on the Ohio, are all examples of cities situated on the banks of rivers at important bends. A **ford** is also a useful point for site selection and several towns in England show this origin by the suffix ' ford ', as Oxford, Hereford, Bedford ; in India the corresponding suffix is **ghat** as in Balaghat and Hinganghat in the Central Provinces. The **confluence** of two rivers affords a still more valuable site. Such towns rise often to great importance if the rivers that meet there are important ; otherwise the town may attain local importance only. The best known city of this type in India is Allahabad (**Prayag**) at the confluence of the Jumna with the Ganges. The rivers are held sacred by the Hindus, and the supposed meeting there of the lost Saraswati gives the name **Triveni-Sangam** (a confluence of three rivers) to the confluence. Patna is at the confluence of the Gandak with the Ganges and is very near the meeting place of the Gogra and the Son with the same river. Attock on the Kabul-Indus, Hankow on the Han-ho—Yangtze, Khartoum on the Blue Nile-White Nile, Belgrade on the Save-Danube, Lyons on the Saone-Rhone, Mainz on the Mosselle-Rhine, Nijne Novgorod on the Oka-Volga, St. Louis on the Mississippi-Missouri, and Manaos on the Negro-Amazon, are other notable examples of this type.

The point where the mode of transport changes gives rise to **transfer-towns.** On **estuaries** there are thus important ports, such as Le Havre, Antwerp, Lisbon, Southampton, London, Hamburg, Riga and many others. In India, on the estuary of the Narbada, Broach has developed a port very well known in very ancient times, while the Tapti estuary has led to the growth of Surat, which was quite important in the Mogul and early British times. The silting-up of the rivers and the increase in the size of ocean-going ships since the advent of the ironclad have robbed some of these estuary towns of a great deal of their one time importances. Where a river enters the sea by means of a **delta,** a town of importance tends to be located at the head of the delta. Hyderabad is thus at the head of the delta of the Indus, Bezwada of the Kistna, Rajahmundry of the Godavari, Cuttack of the Mahanadi. Other well-known delta-towns are Cairo on the Nile, New Orleans on the Mississippi, Astrakhan on the Volga and Rotterdam on the Rhine. Farther up the course of rivers, the limit of navigability for various sizes of ships gives rise to towns of greater or less importance. Thus Cawnpore marks the limit of navigability of the Ganges for fair-sized craft, while Hardwar is the limit for small boats. St. Paul and Minneapolis are similarly important transfer towns on the Mississippi.

The sea coast affords very valuable sites for the growth of ports which if they have good harbours develop into great **commercial centres** like Bombay, Karachi, Naples, New York, Rio de Janeiro and Sydney. Other special considerations give rise thus to **fishing ports** like Grimsby and Yarmouth in England; **naval stations,** like Rosyth, Plymouth, Portsmouth, Pembroke and Davenport in Great Britain and probably Vizagapatam in India; **packet stations** like Tuticorin in India, Dover, Folkestone, Newhaven and Southampton in England, Calais and Boulogne in France.

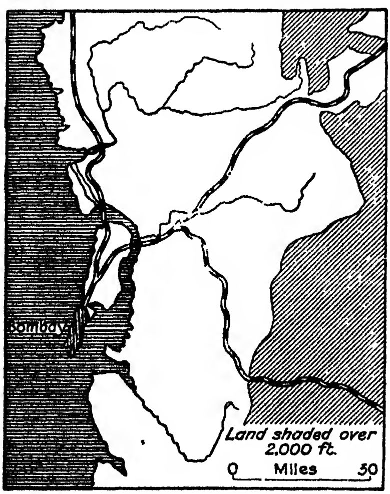

FIG. 85. Position of Bombay

Industrial towns often owe their origin to some special facilities available there for a particular industry. To this class belong Manchester and Leeds in England, Jamshedpur in India, Essen in Germany and Pittsburg in the United States.

Men move in search of pleasure and health, and this desire gradually leads to the establishment of important towns.

The mild winters of the Mediterranean attract people from higher latitudes, and Nice has thus become an important town on the Riviera. Brighton and Ramsgate are **pleasure resorts** for the English, and in some measure, Juhu is becoming, though slowly, to be a similar pleasure resort for Bombay. To escape the heat of the plains of India, people go up to the hills, thus assisting in the rise of important **hill-stations** in the country, the importance of which is considerably increased by the summer migration of governments, provincial as well as central. Thus Bombay has a delightful hill-station in Matheran, only a few miles distant, and the light railway has added to the popularity of the station by increasing its accessibility. Mahabaleshwar near Satara and about 74 miles from Poona is a bigger and most delightful hill-station, which, however, has been losing its popularity with the cessation of the annual transfer there of Government head-quarters in summer. Simla, Murree, Mussoorie, Naini Tal, Almora, Darjeeling, in the Himalayas, Ootacamand and Coonoor in the Nilgiris, Mount Abu in the Aravalis, Pachmarhi and Ranchi are well-known hill-stations in India, the popularity of which for health, rest and pleasure-seekers is

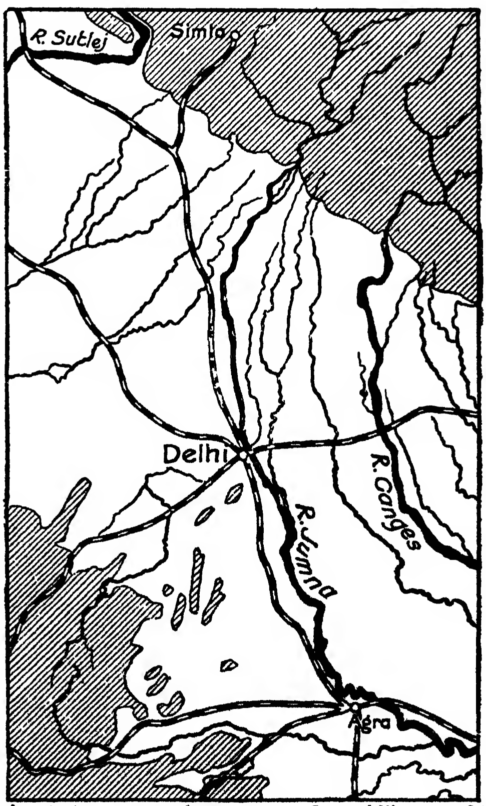

FIG. 86. Position of Delhi

rapidly growing. The mineral waters at some places give to them an increased importance and places like Bath, Scarborough and Carlsbad are well-known **spas.** India has many such spas, which have not yet been well developed.

The grounds for the selection of sites for towns are various, and when a particular site combines more advantages than one, its importance becomes greater. Thus Vienna is near the confluence of several streams and rivers, is easily defensible on account of the natural protection afforded by mountains and by the river, is a nodal town, and as such is in easy touch with many regions, and what is more important, is the capital of an independent state. Delhi has a site no less ideal. Situated between the well-watered regions of the Ganges and the arid lands of the Indus valley, protected by the desert on one side and the mountains on the other, located on an important river with converging routes from the east, north, and south, with a strategic position of no small importance as shown by the decisiveness of the battles of Panipat close by, with the increased attraction of being the imperial capital and the greatest railway junction of the country, Delhi is one of the greatest cities of India. When the administration attraction disappears in course of time, when river mouths silt up, when trade and industries get diverted, cities enter upon a period of decay.

8. ECONOMIC DEVELOPMENT

The economic development of countries is no less subject to geographical control. Progress in commerce or industries is seriously handicapped by unfavourable geographical conditions, though in this case the human factor is perhaps of greater importance. However unfavourable the geographical or natural resources of an area or a region may be, the activity of the state as typifying the play of the human factor can achieve some measure of success, while the passive attitude to the state, no matter how favourable nature may be, is fatal of a rapid development. The rapid progress that Germany and Japan made is more the result of state action than of great natural resources, while the rapid rise of the United States shows the effect of the combined influences of an active state policy and huge natural resources. The effect of the lack of assistance by the state in a region of great resources can best be seen in China.

One of the most important of the geographical factors in the development of commerce in a country is a **variety of products.** This is the result of a variety of climates, which in its turn means a great range of latitude, a great range of longitude, and diversified relief of the land with mountains, plateaux, and plains, with varying distances from the sea and from the equator. The United States, China and India stand out prominently as vast lands offering a large variety of products.

A central situation is also of importance in this connexion. The development of England as a great commercial country from the Tudor period onwards was due to the change in England's situation from being a corner of Europe to becoming the centre of the land hemisphere. Germany has the advantage of being in central Europe. India is central in the Old World, hence its importance before the discovery of America by Columbus ; it is, further, at the head of the Indian Ocean, and its importance to the countries bordering that ocean is perhaps not quite so great today as it may become in the future. **Accessibility** is doubtless an important consideration, inasmuch as a good situation is largely nullified if the neighbouring countries are inaccessible. Rich, advanced and easily accessible neighbours have been an asset to Germany, while poor, backward, undeveloped and inaccessible neighbours have retarded the commercial development of India. The length and character of the **coast-line** are relevant considerations also, a broken, indented and richly articulated coast-line meaning safer and more commodious harbours and ports, a greater association and familiarity with the sea leading to a spirit of enterprise and adventure—priceless assets to a commercial and naval country like England. **Rivers,** long and navigable, render very useful service in a country's development. The European rivers as, for example, the Rhine, the Rhone and the Danube, have played a very important part indeed in the economic evolution of Europe. The Ganges and the Indus, similarly, help us to understand the richness, fertility, dense population, and importance of north India, while the Yangtze and the Hwang Ho account for the progress of the red and the yellow basins of China. Turan owes much to the Sir and the Amu Darya, and the importance of the Euphrates and the Tigris to Iraq cannot indeed be exaggerated. America, however, possesses the finest system of natural waterways and an excellent river system. To the Mississippi, Missouri and the St. Lawrence river systems must be given the credit for throwing open the interior of the American continent, while the broad and the mighty Amazon mingling its waters, through the Rio Negro and the Casiquiare, with those of the Orinoco and almost leading through its great tributaries, the Tapajoz, the Madeira and the Tocantins to the Parana-Paraguay, provides a very useful waterway from the Caribbean Sea to the La Plata estuary. The great development of New South Wales and Victoria, in Australia, is in a large measure due to the great Murray-Darling river system. Egypt owes its existence, its prosperity and its importance to the great Nile, while the unnavigability of the Congo, the Zambesi and the Niger have been handicaps in the exploration and exploitation of the Dark Continent, Africa.

In the utilization of natural resources and in the reduction of the geographical disabilities, the **state** can render immense assistance. A Government, strong and stable, enlightened and sympathetic, is a condition precedent to any progress. In all advanced countries, much has been done by the Departments of Agriculture, Animal Husbandry, Fisheries, Industries, Minerals and Commerce to stimulate and improve production, which is the basis of all exchange constituting commerce; while a programme of education, elementary and advanced, technical and vocational, and wise labour legislation add considerably to the general efficiency of the human material. A wise state facilitates and encourages an extensive and efficient banking organization and pursues a sound currency policy, since these are important instruments of national progress. The provision of transport facilities, railways by land with motor transport for road traffic, shipping by sea and aeroplanes by air, falls very largely within the domain of state action. With the stimulation and improvement of production and of the facilities for distribution, the exchange of commodities, that is, commerce, can be helped by an efficient organization of commercial intelligence, through Trade Commissioners, Consuls and statistical publications and reports. Indeed, the efficiency of the consular service has been a very potent factor in the extension of markets for the products of advanced and advancing countries like Britain, Germany, the United States and Japan. The regulation of prices of commercial commodities by a wise manipulation of the import and export tariffs, adjusted by trade agreements—in other words, preference and protection—is no mean aid rendered by the state in the economic development of the country.

Industrial development. In examining the factors that lead to the development of manufacturing industries in a country, we see that **raw materials** take the front place. It is natural that the raw materials should be worked up into the manufactured product in or near the area of their production rather than in distant lands. Indeed, the presence of an abundant supply of the raw materials represents the basic strength of the industry that works them up, while the dependence for them on foreign countries is a sign of instability of the industry, which will have to rest on the assumption that the centres of production of these materials will continue to remain backward. Today, however, we witness the phenomenon of the world divided into two main groups—those producing the raw materials and those importing the materials and manufacturing them into products and exporting these to the former groups. This introduces a great element of instability; and the tendency towards industrialization of the raw-materials producing countries causes considerable alarm, misgivings and dislocation in the industrial organization of the advanced lands. These lands owe their industrial development to two other factors—machinery and power. **Machinery** depends upon a well-developed iron and steel industry, which itself demands the close association of rich iron ores and coal-fields. The sources of **industrial power** are many indeed. But we have gone beyond human and animal power, wind and water power. It is steam power based on coal, that has led the way in modern times. Coal is useful in the smelting of iron ores and in the making of steel. Therefore countries rich in iron ore and coal soon become industrial countries, and can afford to import raw materials from abroad. New sources of power have, however, been coming into great prominence. Apart from the possible utilization in the future of the power derived from the rays of the Sun, and the tremendous energy of the waves of the sea and the tides, mineral oil (petroleum) and hydro-electric power have already become serious competitors with coal in providing industrial power. Coal and iron ores are no longer, therefore, the determining factors for the development of manufacturing industries. The great Tata hydro-electric companies are supplying power to the great cotton textile industry of Bombay. The Niagara Falls have been harnessed for similar purposes, and the **'white coal'**, as the Americans call this new power, is important in the south-east of France, in Switzerland and in Scandinavia. The balance is already shaken; industries are being built up in other lands, and the factors that count today are rather more adventitious than natural. The availability of **capital** (borrowed capital proving often undesirable on account of rights and privileges attached), the availability of a **labour** force sufficient and efficient and cheap, skilled labour and scientific **management** or organizing ability, **state aid,** drive and push, efficient and cheap **transport** and large and assured **markets** are now the elements that spell success in the struggle between countries for industrialization. Trade agreements, quotas, exchange controls all aim at capturing, retaining or sharing markets for the products of the industries of various countries. Here, too, the human factors, organized and led by the state, are of far greater importance than the geographical distribution of raw materials, iron ores, coal, oil or hydro-electric power.

Localization of industries. We often observe that some industries become concentrated at certain centres. Thus we have cotton manufactures centred in Lancashire in England, at Bombay and Ahmedabad in India, and the iron and steel industry concentrated at Birmingham in England, at Pittsburg in the United States, and at Jamshedpur in India. The silk industry at Lyons, shipbuilding at Glasgow, woollen manufactures in the West Riding of Yorkshire, at Cawnpore and Dhariwal in India, cutlery at Sheffield, and so forth, are other instances of concentration. This **localization of industries** can usually be accounted for by the functioning of some of the factors referred to above in connexion with the development of industries in a country. But in many cases, some special and peculiar cause operates to draw an industry to a region, such as a moist climate for cotton-spinning, a good supply of water for washing, bleaching and dyeing silk and wool, and grinding stone for cutlery. In very many cases it happens that the special cause that operated to locate the industry in an area has ceased to be effective, and yet, **geographical inertia,** the momentum of an early start, keeps an industry where it was first located. Thus the glass bangle making industry at Firozabad in India has continued successfully, not because there is sand or fire-clay or coal close by, but because there is a large and skilled population there, as a result of the early start. Lancashire and Bombay also maintain their prominence now, rather because of geographical inertia than of any very great facilities there which are denied to others.

Chapter VIII

PROGRESS AND PROBLEMS OF COUNTRIES

1. GENERAL

The progress of different countries has not been uniform; some lands have progressed faster and developed better than others; others have advanced but slowly or not at all; while yet others have gone backward and have lost the position which they once held. This progress has certainly been largely influenced by the geographic factor, but none the less by the extent of the power and far-sightedness of states in utilizing this factor to the best advantage, and in reducing any handicap as far as possible. The keynotes of modern civilization are world economy and international trade, which require mechanized industry, large scale production, swift means of transport and communication by land, sea and air, and assured, controlled and large markets. This has led to a division of the world into two types of countries: those that produce raw materials and food-stuffs; and those that utilize these and produce manufactured articles—the agricultural and pastoral lands and the industrial countries respectively. The agricultural and pastoral lands thus become the sources of supply of raw materials and food-stuffs, and the markets for the finished products of the industrial countries. As industrial development is based on a well-developed iron and steel industry and the production of machinery, on resources of industrial power like coal, oil or water for hydro-electricity, on large amounts of capital available and on scientific organization and efficient labour, it follows that countries with large resources in coal and iron become industrialized rapidly and seek to exploit commercially and economically the producers of raw materials. These countries also provide markets for the manufactures of the industrial areas. The advanced countries therefore seek to maintain and extend their power by maintaining or acquiring control of large groups of people, by political conquest or by economic penetration strengthened by treaties, financial assistance and other means. Of the densely peopled parts of the world, India and China are most important. England has won the greatest prize in its political domination over the vast population of India; but China remains a prize yet to be acquired, and therefore attracts the covetous gaze of the industrial lands like Japan, the United States and England. Colonization, trade settlements, and mandates are therefore of importance in the competitive struggle of these lands for large and assured markets. To protect their trade, advanced industrial lands have to seek and establish strategic centres on important trade routes, and with the advent of oil as a very important source of industrial power and for transport in peace and war, they eagerly seek to acquire control over lands where there are possible resources of oil.

Backward nations are, however, now making progress, and the great problem of the world, therefore, is to find a means of reconciling the desire for retention of the opportunities for economic exploitation on the part of the leading powers, with the desire on the part of the erstwhile backward powers to acquire such opportunities for themselves among peoples still more backward than they. How to reconcile the desire for the *status quo* of one group with the desire for aggression of the other; how to reconcile the genuine desire and struggle for peace of the 'Haves' with the strong desire and struggle for war of the 'Wanting to Haves'. While countries like England and France, which have for several generations had great influence in the Old World, and America which has become the predominant power in the New World are powerful advocates of peace, Germany and Italy, Russia and Japan, who having mechanized their industry and developed their transport, now clamour for markets, for large populations which they may control. They desire, as they say, 'a place in the sun'. It is no longer possible, as in the old days, for the desired end to be achieved by the explorer, followed by the missionary, the merchant and the soldier. The flag could then follow the trade; it has now to precede it; or where that is not possible, attempts are made to achieve the end by economic concessions through trade agreements and pacts. This is the geographical background of the great problems that confront us today. The aggressiveness of Italy and Germany, the determined development of Japan, the intensity of the Soviet programmes have their basis in their own developed industries which demand populations to consume their products, controlled by treaties and acts—economic or political, pacific or in the last resort militant.

2. INDIA

A sub-continent. India is a vast land and is rather a sub-continent than a country. When we talk of national unity and a common language, this fact is often forgotten. The great variety of geographical conditions, apart from the vast size and vast population, makes India a sort of geographical laboratory of the world. Polar and equatorial, tropical, sub-tropical and temperate, extreme continental and equable marine, oceanic and littoral climates are to be met with in different parts of this great land, so that agricultural products which are effectively controlled by climate present a bewildering variety. Different races, the Aryans, the Dravidians and the Tibeto-Burmans, the brown, the black and the yellow, inhabit India. The restless Pathan of the Frontier, the sturdy Sikh of the Indus valley, the thrifty Marwari of arid Rajputana, the intelligent Bengali of the lower Ganges basin, the commercial Gujarati of the western plains, the wiry and active Deccani of the plateau, the gentle South Indian, are examples which reveal the variety usually associated with a large continent with heterogeneous conditions, rather than with a country having a great measure of homogeneity. India has a size equal to that of Europe excluding Russia, a population about one-sixth of the total population of the world, great contrasts in configuration and build, in climate and products, in peoples and their races, languages, religions, customs and characteristics; and the naturally correct line of progress for India would be to seek to promote the intensive development of her various regions, and to achieve a federation for a unified foreign policy, rather than to attempt homogeneity for the whole. The true path of progress lies in unity with diversity, in internal diversity federated into external uniformity.

Natural divisions. India falls into four major regions: the mountain regions in the north, the river plains in the middle, the coastal plains and the plateau region in the south. These major regions yield on closer analysis many more units, when the geographical conditions, the economic products and the peoples are considered. The mountain region gives us the northern mountain region, including the famous valley of Kashmir, the north-eastern region separating India from Burma, and the north-western region forming the important frontier between India and her north-western neighbours, which has played an important part in India's history from the early Aryan incursions to the present day. The river plains fall into two regions, the plains of the Indus and of the Ganges, these being further subdivided into sub-regions, the middle and lower basins of the Indus and the upper, middle and lower basins of the Ganges. Add to these the plains of the Brahmaputra, the desert plains of Rajputana and the stony lands of Orissa, and the natural division of the continental land mass of India is fairly complete. The tableland regions give us Central India and the Deccan which is subdivided into the regions between the Vindhya-Satpura mountains and the Godavari, the Godavari-Kistna region and the Mysore plateau. The coastal plains can be divided into Gujarat, accessible through the valleys of the Narbada and the Tapti, the Konkan, shut out from the interior by the escarpment of the Western Ghats, and Malabar, with its famous backwaters and lagoons and plantations, all on the western coast with heavy monsoon rains; and the Cauvery basin, Andhra and the Orissa coasts on the east. It will thus be seen that the political divisions of India approximate to the natural divisions of the land, and with separation of Sind from the Bombay Presidency, and of Orissa, this approximation becomes closer and closer. Language is often a very suitable indication of the homogeneity of a region, and the natural regions of a land closely approximate to the linguistic divisions therein. In the further recognition of the correlation between the linguistic and economic units and in the greater correspondence of political divisions with linguistic regions, lies the path of intensive development and economic progress of the various parts of this great sub-continent, which will make for much greater progress of the whole.

Products. The great variety of climates and range of latitude gives to India a great variety of products. Among the cereals, rice in the middle and lower Ganges basins, the Godavari-Kistna deltas, and the Konkan coastal strip, and wheat in the middle Indus, the upper Ganges and the upper Narbada valleys are the most important in the foreign trade of the country, though from the point of view of the consumers in the country, the great and the spiked millets—jawar and bajra—are no less important. Among the fibres, cotton in the black cotton soil regions of the Deccan trap, and jute in the lower Ganges valley have given to India considerable importance in international trade, India standing second only to America in the quantity of cotton produced, and enjoying an almost complete monopoly in jute. The funnel-shaped valley of Assam and the Nilgiri region in the south have developed a huge production of tea and coffee, the beverages that delight the world. The sweetening sugar and the soothing tobacco in the upper parts of the United Provinces and Bengal, linseed in the Central Provinces, rape seed in northern India, ground-nuts in Bombay and Madras, sesamum more generally, and a host of other oil seeds and nuts including copra, hides and skins in the upper Ganges and Madras, the coal-fields of Raniganj and Jharia and the iron ores of Gurumaishini, Kulti and Salem give to India a wealth of products sufficient to maintain a huge population throughout the numerous vicissitudes of fortune through which the country has passed during the ages.

Railways. There was a time when all this great wealth of agricultural production did not save the people in some parts from suffering from the terrible scourge of famines. The primitive means of transport meant the co-existence of plenty of food from bumper crops in one part, and serious shortage through the total failure of the crops in another. Railways have now made famines a thing of the past and have led to a great development in the internal and external trade of the land. With a mileage of over 40,000 miles, the railways are serving India fairly well, though compared with the standards of England or America, the mileage must at least be doubled before we can regard the railways as adequate for our needs. Constructed in the fifties and sixties of the last century for strategic and administrative purposes, the railways of India have served fairly well the commercial needs of the country. The question of company management versus state management has now been decided in favour of the latter, and with the principal lines owned and worked by the state, with feeders here and there and with motor transport showing strong signs of development, the inland transport system of India must be regarded as fairly efficient and adequate. The ports, Bombay, Calcutta, Madras, Karachi and Vizagapatam, and the great inland centres like Delhi, Agra, Cawnpore and Allahabad, are interconnected. Indeed a very fair idea of the geography, ethnology, trade and industries of the country can be obtained by undertaking a tour along the main trunk lines of Indian railways.

Principal railway routes. The **Frontier Mail** route takes us from Bombay through the transitional zone between the Konkan and Gujarat to the fair fields of cotton-producing South Gujarat, and thence ascending to the Malwa plateau, takes one on more or less by way of the Chambal valley through the land of romance and chivalry of medieval India, Rajputana, to the well-watered plains of the Jumna, with its Agra and the Taj Mahal, Muttra and Brindaban, and Delhi the great historic capital, and thence farther on across the great Punjab rivers to the frontier region of Peshawar and Landi Khana and the Khyber. The **Imperial Indian Mail** similarly gives us a good idea of the Ghats, the region of the Tapti valley, the narrow upper Narbada valley, of the limestone areas of the Vindhyas and the plains of the middle and lower Ganges, from Allahabad to Benares, Patna, Gaya and the coal-mining centre, Asansol, to Howrah and Calcutta, Bombay's great compeer in the east. The **Grand Trunk Express** route, one of the longest connected routes in the world, takes us from Mangalore to Peshawar. Passing along the coast from Mangalore, it enters the plains of southern India through the Palghat gap ; reaching Madras, it goes along the eastern coast to Bezwada at the head of the Kistna Delta ; it then turns north-westwards into the Nizam's Dominions and reaches Nagpur by way of Kazipet and Chanda. From Nagpur, across the Satpuras to Itarsi and across the Central India plateau to Bhopal, the route goes down the valley of the Betwa to Jhansi and Gwalior, and Agra and Delhi. The last stage of the route takes us from Delhi to Peshawar. The stages from Mangalore to Madras and from Delhi onwards are made by connexions.

Ports. The ports are centres through which our products go out and foreign products come in. We have at present only four major ports—Bombay, Calcutta, Madras and Karachi. A fifth, Vizagapatam, has recently been constructed. But with a coast-line as long as ours, and with a foreign trade developing so quickly, these appear to be too few. There seems to be enough scope for many minor ports, at any rate. On the eastern coast, we have indeed many such ports—Negapatam, Masulipatam, Cocanada, Pondicherry. On the western coast, Alleppey, Quilon, Cochin and Calicut with Goa are well known ; of late, however, the Kathiawar States have been developing their ports, Bhavnagar, Okha, Bedi Bandar and Navlakhi ; and though these might for the time being harm the trade of Bombay, they will, in the long run, help the commercial development of the country as a whole, by creating facilities for imports and exports in those parts where there were none before. The separation of Sind will probably mean greater efforts by the Sind Government, and though Karachi is already important as an airport and a passenger port, its importance as a commercial port will very likely grow with the development of Sind with its Sukkur Barrage.

Problems. The problems that confront India on her march of progress are not those of an unfavourable geographical environment. With an extraordinary wealth of resources, and a very large population, and with a dominating situation in the centre of the eastern hemisphere, and at the head of the Indian Ocean, she requires rapid industrialization, free intercourse and developed relations with the countries bordering the Indian Ocean. East and South Africa, Australia, south-western Asia and south-eastern Asia clearly fall within the orbit of Indian progress ; and with increasing approach to Dominion Status within the British Empire, with favourable fiscal autonomy to build up protective barriers for her industrial growth, with increasing prestige to fight the colour bar in the white Australia and the white South Africa policies, and towards that end, with an intensive campaign for education and the consequent increasing efficiency of the human material, India can view with equanimity her great future as indeed the brightest jewel of the British Crown. Internal problems such as those of Hindu-Moslem unity, the backward and depressed classes, and Indian feudatory states are big problems no doubt, but their solution lies largely in education and in self-government as a partner in the British Commonwealth of Nations. It is only when knowledge is combined with power that the barriers born of prejudice, ignorance and conservatism can be demolished, and a unity can be woven out of diversity, yielding a broad national outlook combined with local aspirations of smaller autonomous regions of the sub-continent. India has always been a difficult country to dominate, but the peculiar genius of the British people has enabled them gradually to eliminate the iron bonds of domination and to replace them by the silken ties of sentiment and goodwill, so that the Indian, no less than the Canadian, South African or the Australian, is content to remain, rise and develop under the aegis of the British Commonwealth of Nations.

3. GREAT BRITAIN

Great Britain is a wonderful country which has achieved a unique position and power in the world of today. Detached from the mainland, the island lies in a corner of Europe, and was exposed to invasion by maritime people, like the Vikings and Danes. Even the Romans occupied it for a time, and ultimately the Normans established themselves in the land. The highlanders of Scotland, the mountain people of Wales, the Irish of the neighbouring island, and the lowlanders of England gave a diversity of people, so that progress was difficult.

Unification of the British Isles. The first objective was therefore the unification of the British Isles. The conquest of Wales by Edward I was the beginning of this process, and the conquest of Scotland by the same King would have advanced it farther ; but the early death of Edward I and the weakness of his successor led to a protracted struggle between the two peoples. No great progress for England was considered possible unless it acquired a footing on the mainland ; and to that end the English Kings asserted a claim to the throne of France, and brought about a war between the two countries that lasted more or less for a hundred years. With the advent of the Tudors, Scotland was not yet absorbed, Ireland still remained separate, the ambitions in France were crushed ; but the unification and consolidation of England itself was achieved by the destruction of the feudal nobility, so that England emerged as a strong nationalistic state.

Colonial expansion. The geographical explorations of the period were the turning point in the progress of England. Its people realized that its future lay, not on the mainland of Europe, but on the seas. English policy aimed thenceforth to make England the mistress of the seas. Colonization progressed actively, and the Dutch, who had captured the carrying trade of the world, became antagonistic to England, which under Elizabeth set itself the task of building up a strong navy and a large mercantile marine, and under the Stuarts of wresting the carrying trade from Holland. The Navigation Acts and the Dutch Wars represented the fundamental policy of England, and the victory won placed England on the road to progress. England had previously failed to make itself felt as a European power ; but in the age of colonization England soon carved out for itself a position as a great world power, its chief rival being France, its neighbour across the Silver Stream, which had also realized the advantages of its position as almost central in the land hemisphere, and of the value of the commercial exploitation of colonies. The two neighbours in their rivalry for world power waged war as protracted as the Hundred Years' War. Meanwhile, the union with Scotland was effected under Queen Anne. In all European wars of the period England and France ranged themselves on opposite sides: whether the dispute was about the Spanish succession or the Austrian succession, the Stuart restoration in England or the Bourbon restoration in France. The colonial issue was decided at Plassey and Quebec in favour of England which won large areas in North America, and made possible the control of the huge population of India. The French ambitions were shattered, in spite of the set-back to Britain by the secession of its American colonies and the brilliant Napoleonic interlude. What Cabot and Drake began, and Clive and Wolfe furthered, Nelson completed ; and England stood out in the nineteenth century as the undisputed and unchallenged **Mistress of the Seas** and the largest colonial power. The discovery of Australia and the colonization of this island continent and of New Zealand, increased the power and prestige of Britain. France, too, was gradually building up a colonial empire in northern Africa and Asia, and the definite abandonment by France of a policy of active rivalry with Britain led to the abandonment of the age-long hostility between them, and promoted amicable relations which continue unbroken. The British and the French flags flew side by side on the plains of the Crimea and on the battlefields of Ypres, the Aisne, the Somme, and the Marne.

Industrialization. Large resources of coal and iron, mechanical inventions, colonial markets, and the profits of the Indian trade, brought about in England the Industrial Revolution and an industrial civilization, and trade became its life-blood. The one-time granary of the Roman Empire and the strong adherent of the Corn Laws during the sway of Mercantilism, now allowed agriculture to recede into the background and concentrated on building up its manufacturing industries; and there arose an international division of labour under which it became the workshop, the banker and the carrier of the world, while its colonies and dependencies and other backward lands remained the 'hewers of wood and drawers of water', the farmers, and shepherds of the world. Exploration in Africa and the scramble for the partition of that continent resulted in the accretion of further areas to its vast empire, and Central and South America would have yielded their quotas too but for the Monroe Doctrine of the United States, which shut out European interference in the affairs of the Americas. In the first phase of England's imperial life, trade was dominant; but in the second, up to about 1850, came a quick burst of activity that dotted the world with British possessions.

Self-governing Dominions. Great Britain has thus built up a huge and unique empire, the vast areas of the Dominions conferring prestige and the vast population of India yielding profit as well. The scattered units of the Empire have to be protected against foreign aggression, and the guiding policy of Great Britain thus remains unaltered: namely, to maintain an effective naval supremacy, and to secure the vital lines of communication between them. A great lead in industrial production enabled it to discard state regulation for free trade, which brought in prosperity and progress. Meanwhile colonies clamoured for self-government and South

Africa even backed up its clamour by an armed clash, the Boer War. The needs of the colonies for external protection and the need of Great Britain for raw materials and markets led to the evolution of Dominion Status, which by the Statute of Westminster of 1931 implies an autonomous community within the British Empire, equal in status, in no way subordinate to another in any aspect of its domestic or foreign affairs, though united by a common allegiance to the Crown, and freely associated as a member of the British Commonwealth of Nations.

The fundamentals of the economic policy of Great Britain are not, however, affected by this conferment of Dominion Status on the Irish Free State, Canada, Newfoundland, the Union of South Africa, Australia, and New Zealand ; they are not industrial lands, nor likely to become so within a short period of time, and the increase in the political status merely substitutes the silken bonds of love and sentiment towards the Motherland for the iron shackles of avowed subordination and exploitation. This is the third period of England's imperial history which saw the emergence and development of those English-speaking Dominions, which, though independent, are important centres of British greatness—political, industrial and commercial.

Meanwhile foreign countries began to make up leeway and made rapid strides, so that by the beginning of this century England began, to some extent, to lose the markets it had controlled hitherto, and the United States, France and Germany and latterly Japan, began to encroach on its preserves. The Great War, however, added a few areas to the British Empire as a mandatory power under the League of Nations.

Desire for peace. At this stage of its progress, Great Britain desires nothing so ardently as peace, so as to maintain the *status quo*, the balance of economic and political power and its consequent advantages. But it cannot allow its naval supremacy to be challenged ; it cannot afford to neglect the links of the Empire and strategic vantage points along its great trade routes. Oil being now an increasingly important source of industrial and military power, England is keenly desirous of controlling effectively lands with oil resources. The increasing importance of aeroplanes for military and transport purposes makes it as essential for Britain to build up a chain of air bases to safeguard the imperial airways as to maintain naval bases along the vital sea routes.

Links of the Empire. The retention of controlled markets, and of assured supplies of necessary food-stuffs and raw materials, the control of oil regions, the security of vital lines of communication, strategic air and naval bases, naval and aerial supremacy, and withal peace, are the problems of policy on which the progress and prosperity of Great Britain and its Empire largely depend. The Indian Ocean is dominated by British influence. British possessions stretch along the Atlantic borders from Gibraltar to Cape Town, thence along the borders of the Indian Ocean to Zanzibar and farther to Aden, and the coasts of Iran and India. In the Mediterranean Sea, Malta has been British since 1803. Hong-Kong was obtained from China in 1842. The British sphere of influence in Iran has become established since the beginning of this century. **Singapore** is a great commercial and naval base that illustrates very well the significance of the location of many links in the chain of the Empire. It carries on a vast entrepôt trade in cotton textiles, petroleum products and tobacco and in rubber, tin and rice. As a naval base, it guards the Far Eastern trade route, commands the Dutch East Indies, contributes to the outer defence of India and is of considerable importance in the defence of Australia.

4. THE BRITISH EMPIRE

(i) Ireland

The tragedy of the geographical situation of Ireland is that it is an ' outpost ' of Europe, near enough to England for conquest and yet far enough away to prevent assimilation and good relations. As has been truly remarked, while Canada and Australia are geographically remote but morally near, Ireland is geographically near but morally remote.

Differences with England. Ireland remained an isolated island and developed an indigenous culture, literature, art, and tribal system of government. Religious differences have added to the complexities of political and social differences. The Catholic peasants were kept under control by Protestant landlords and their soldiers; the 'Plantation of Ulster' accentuated these differences and made Ulster a sore spot to the Irish, a symbol of English dominance and Protestant landlordism and tyranny. Trade restrictions in the seventeenth century encouraged emigration, first to America and latterly to Australia and New Zealand as well, and also encouraged a consuming hatred leading to perpetual disorders. Even during the World War, there was disorder and conflict in Ireland. At last in 1921, Dominion Status was granted to Ireland which enters upon a new period in her history, where her economic troubles have to be solved by her own national parliament and no longer by rioting and armed clashes or by acrimonious disputes with the British Government. Her troubles are, however, not yet over. With de Valera's rise to power, the problems of independence on the one hand, and of unification of the whole country by the absorption of Ulster on the other are creating troubles with England, and though moderation has prevailed on both sides, difficulties are still immense and it is not likely that Ireland's economic problems will be immediately solved.

A source of trouble. Ireland has been for centuries a problem to England. It has ever been the seat of chronic dissatisfaction towards English domination, which has been exploited by others as a jumping-off place for an invasion of England. Richard II went to Ireland to punish the chiefs and returned to find his throne usurped by Henry IV. The later years of Elizabeth were clouded by troubles in Ireland, Cromwell had no peace, and the Jacobites found asylum and refuge in that land. Napoleon, too, dreamt of Ireland as a base for his invasion of England as did Germany in the World War. Now, however, a self-governing Ireland, independent within the British Commonwealth of Nations, is more likely to develop attachment for England and the Empire; for domination and exploitation have been replaced by equality and autonomy, so that a free and prosperous Ireland maintaining diplomatic representatives in foreign countries like the United States, Germany and France may now be a source of strength to England instead of being a danger spot.

Progress. Rainfall is abundant; grass grows well, but cereals are difficult to grow; dairying dominates her rural economy. The principal food crop is the potato; and occasional failures of pasture and potato have led to emigration, so that the population has been declining and is now less than 3,000,000. Ireland, like India, is a land of small holdings, of uneconomic units, and among the measures adopted for the benefit of the peasantry, the inauguration and success of the co-operative marketing organization are very remarkable developments. By taking advantage of laws which have been passed expediting and facilitating the purchase of land, a large number of tenants have become proprietors of their lands. In the last few years, improvements have been made in the livestock and dairy products, so that they command increased attention in the markets of the world. The trade is mainly with Great Britain, and among the principal exports, cattle and livestock predominate, with butter, eggs and beer and ale, following; while the imports are chiefly those of coal, wheat, tea and manufactured articles.

(ii) Canada

Canada, the senior daughter land of the British Empire, lies in a northerly latitude, so that the growth of population and the development of the land have been principally along the southern border, in lands adjoining its great neighbour, the United States. The vast stretches of the sub-arctic lands are gradually attracting some population northward, but these lands can, even when better developed, support but a sparse population, so that the main bulk of the population will remain confined to the long and narrow east to west belt, from the Atlantic to the Pacific; and it is this southern part of Canada that will remain the land of power and progress, leadership and initiative, trade and industry, and of vital interest and political importance to the British Empire and the United States.

Occupation of the west and north. The population according to the Census of 1931 is 10,400,000 and the area is about 3,700,000 square miles. With more than double the area of India, it has a population less than that of the Bombay Presidency. Of the area, about 1,300,000 square miles are in the sub-arctic lands of the North-West Territories.

The population has been expanding westwards; settlements are being advanced on the distant frontiers and these are being better connected. New lands still await occupation; and colonization and settlement are actively in progress in all directions. There have been three stages in Canadian colonization. The first was the settlement of the east. This was followed by the advance to the west and the north-west. The third stage is the present northward movement, not only in north-western regions but also in northern areas of the eastern provinces. Science and exploration have dispelled ignorance concerning the northward limit of the growth of cereals, for quick maturing varieties of wheat can be grown up to about latitude 55° N., and the cultivation of these has promoted the westward and northward wave of immigration.

Immigration. The people of Canada present a bewildering variety. Almost all European countries are represented, and there are a few Chinese and Japanese and a few Negroes. The British Canadians predominate with a population of about 5,400,000; the French Canadians come next with over 2,900,000, and are particularly important in Ontario and Quebec. Lumbering, mining and the development of water power here represent the principal occupations of the people, and supplement agriculture. In the north-west the population is varied, there being the French and British Canadians as well as large groups of foreigners, such as the prosperous Ukrainians, numbering about 225,000. In British Columbia, Asiatic immigration forms a problem of great significance, for of the 46,000 Chinese and 23,000 Japanese in Canada, the great majority are in this province, employed in fruit and fish canning, coal-mining and wood industries. They have entered the retail trade also and have acquired large possessions in this province. Asiatic immigration has therefore become an important foreign problem of Canada, and has led to measures restricting the number of immigrants, their power to acquire property and their power to vote. Canada, the United States and Australia have all adopted similar policies on this problem of the immigration of the coloured peoples from the East, and this solidarity of the whites on the eastern borders of the Pacific realm produces a situation of intense instability that continues to disturb Pacific relations.

Relations with the United States. The growing economic dominance of the United States has been a cause of much embarrassment to Canada. At the beginning of this century, the construction of railways in the Far West was proceeding with vigour ; the country was being actively opened up and developed ; the industries began to be effectively modernized and Canada realized a sense of nationhood as never before, but which made her realize her dependence upon the United States. American investments in Canada have increased very rapidly, while the British perhaps just manage to maintain their position ; more than 50 per cent of the industries are controlled by outsiders though owned by Canada. In commerce, Canada has relations with the West Indies, Europe and the Far East, but the part which the United States plays in her industry and trade is very large. The developments in organization in that country, the great influence exercised by its big business, large-scale production in industry with its standardization of parts, labour-saving devices and the consequent lowering of the cost of production, efficient transport, and marketing organization are factors which have given to the United States an economic ascendancy over Canada out of all proportion to mere population. The regional tendency of Canadian trade with the United States is countered by confederation and the construction of the transcontinental railway systems. The continued presence and growth of the sentiment of loyalty towards Great Britain is a remarkable phenomenon fostered by leaders in Great Britain and Canada, so that Canada sets a higher value on its place within the British Empire than on a possible union with its big neighbour.

The enormous growth in the use of the Great Lakes—the St. Lawrence waterway—has made this route so important to both the United States and Canada for the trade in iron ores and grain that improvements therein are a matter of joint concern. The new and larger Welland Canal opened in 1931 and the canalization of the unnavigable sections of the St. Lawrence permit ocean-going vessels to reach any part of the great lakes. With smooth-working agreements and the equitable use of common resources, the relations between Canada and the United States have become very friendly and harmonious, and with the important position and status that

Canada enjoys in the councils of the British Empire, the freedom that it has been granted in negotiations with other countries, the appointment of ministers in foreign countries like the United States, France and Japan, Canada is making rapid strides towards economic development and a fuller nationhood.

Trade. The trade of Canada is principally with the United States and Great Britain. Britain imports from Canada more than she exports thereto; the reverse is the case with the United States. The leading imports are mineral oil and coal, fruits, sugar, machinery, cotton goods and alcoholic beverages, while the leading exports are wheat and meat, paper and woodpulp, nickel and copper.

(iii) The Union of South Africa

Population. The total area of the Union is about 475,000 square miles with a population of about 8,500,000 of whom the European population was estimated at 1,900,000 and the non-European at 6,600,000. The quinquennial censuses of 1926 and 1931 were restricted to Europeans, and only the non-European population can therefore be estimated. The Union is largely a miner's country, the Cape of Good Hope being the most important for diamonds and copper, Transvaal for gold, diamonds and coal, Natal for coal, and the Orange Free State for diamonds.

The exports are naturally, therefore, dominated by gold and diamonds, though wool and hides and skins are also important. Imports are mostly of manufactured articles and machinery. Great Britain is the chief market and source of supply, but large exchanges are also made with the other parts of the British Empire and the United States.

Dominion Status. By 1900 large numbers of English settlers had established themselves in South Africa. The discoveries of gold and diamonds in that region attracted large amounts of capital which gave a further stimulus to white settlement. The political control of England was strengthened and extended; and the Boers or settlers of Dutch descent, and the black natives, were displaced from their original settlements. The Boers 'trekked' farther northward and settled permanently in the Transvaal. Relations between the English and the Boers continued to be very bad, culminating ultimately in the Boer War at the end of the last century. In 1910, a few years after the end of the war, however, the Union of South Africa was formed, as a new self-governing Dominion within the British Empire. The new orientation of British policy at the Imperial Conference of 1926 and the creation of independent states within the British Commonwealth of Nations have dispelled any idea of a secession from the British Empire, and the Boers and the British are co-operating to accomplish the economic development of their country.

Racial problem. But the great problem that faces the Union is the racial problem. There are more than 150,000 Indians and the native black people number about 6,500,000, and the racial problem is the greatest obstacle to the rapid progress of the land. In face of this overwhelming majority of the coloured peoples, it is very difficult to attempt to keep the Union a white man's country. The number of poor whites with low mentality is increasing, and it pays economically to employ the cheap natives. Those whites who have capital invest it in industries, and employ cheap black labour and maintain a fairly high standard of living ; but those who have no capital tend to sink to low social and economic strata. Another difficulty is that the regions sufficiently high to be cool enough for the white man are usually too dry for ordinary agriculture. The efforts of the Union Government therefore to encourage economic development by undertaking geological explorations and comprehensive irrigation schemes, do not apparently help South Africa's efforts towards becoming a white man's country. Indians refuse to be treated like natives, and the whites refuse to recognize three distinct cultural types —European, Indian and native—and take their stand on the colour differentiation. Indians have been sorely handicapped and they have been fighting a losing game in South Africa. The refusal of the Government to issue trade licences from May 1919, and the restrictions upon property ownership in the Transvaal under the Asiatic Trade and Land Act of 1919, aroused widespread resentment in India, as a result of which a Round Table Conference was held where India, functioning as a Dominion, negotiated with another Dominion. Thereafter India appointed an Agent in South Africa. The Indian problem is being solved by repatriation, a form of assisted emigration of the Indians back to their over-populated homeland from an under-populated land which, however, seeks to maintain itself as a white man's country. Apparently national energies are being concentrated not on economic and industrial development, but on the social problem: not, indeed, a very happy state of affairs.

Mandatory power. German South-West Africa has been assigned to the Union as a mandatory power, but the Union has made ever-increasing claims to ultimate sovereignty, and the problem of the return of the German colonies becomes therefore an acute problem to the Union of South Africa.

(iv) Australia

The Commonwealth of Australia, consisting of the six original states of New South Wales, Victoria, Queensland, South Australia, Western Australia and Tasmania, was proclaimed on 1 January 1901. Its area is about 3,000,000 square miles and its population is about 6,700,000, New South Wales and Victoria having the largest population, about 2,600,000 and 1,800,000 respectively, and Queensland having about 1,000,000. It is the smallest of the continents, being about three-fourths of Europe in size, and is the only one entirely in the southern hemisphere. It is the most isolated of all continents. It is bisected by the tropic of Capricorn, and thus lies in the tropical and sub-tropical regions. It is almost entirely a white man's land, the aborigines having decreased in numbers continuously, and today they number only about 30,000.

Australia has had a curious history. It first came to be known to the Dutch and the Portuguese who called it New Holland. Captain Cook's voyages, however, from 1769-71 along the shores of New Zealand and the eastern coast of Australia brought it to the notice of England which founded a convict settlement at Botany Bay, the site of modern Sydney on Port Jackson. There was no development, however, till in 1851, when the discovery of gold at Ballarat infected England with the gold-fever and attracted numerous emigrants. These found that gold mining was not an easy job and many soon settled down to develop the country.

Production and trade. The centre and the west are largely tropical desert. The productive parts of Australia lie along the coasts with a wider belt on the eastern coast, particularly in the southern part, the basin of the Murray-Darling. Forests occur in well-watered margins and highlands, and in the monsoon and the Mediterranean type of areas, with the eucalyptus family ranging from small shrubs to giant trees about 400 feet high, the acacia, the jarrah and the karri as the characteristic trees. Australia is, however, the farmer's and shepherd's country, though mining is also important. Wheat, wool and gold are the chief products, the former in South Australia and Queensland, wool in the treeless grassy plains bordering the Murray-Darling in New South Wales and Victoria, where the squatters have made large tracts into sheep runs, and gold in the western tablelands and eastern highlands. These, with hides and skins, meats, fruits, butter and eggs, form the chief exports, while imports are largely of manufactures, mineral oil and tea. Great Britain dominates the import and export trade of the country, while the United States comes next in imports and Japan in exports.

Railways. Railway communication has not yet been much developed, there being only 27,108 miles of railways in the vast area. A coastal transcontinental railway from Rockhampton to Perth, via Brisbane, Sydney, Melbourne and Adelaide and the goldfields of Coolgardie and Kalgoorlie has been constructed, but another, a north to south line, is still incomplete. The northern section from Port Darwin has reached a distance of 316 miles to Birdun, while the southern section from Adelaide has reached Alice Springs.

White Australia policy. Isolation and a small population have been potent forces in retarding the development of this land. The white Australia policy creates the problem of keeping out the Malays, the Indians, the Chinese and the Japanese, and as the Australian Premier remarked in 1903, the choice lies between filling up spaces with immigrants from Britain, and, if need be, from other European countries, and being swamped by coloured people from the overcrowded countries of the world. Australia has chosen to adopt the policy of exclusion of the coloured races. About 98 per cent of the whole area is occupied by persons of British origin. Asiatics are very few in number, probably about 35,000, of whom about 23,000 are Chinese. This restrictive policy is favoured, not by a group or a party, but by the whole Australian people. The status of labour in Australia is remarkably high, and the labour unions have been among the most active elements in upholding the policy of exclusion. The near approach of Japanese influence, in the Marshall and the Caroline Islands, creates apprehension of increasing Japanese colonization in the Pacific islands and of harmful reaction upon white labour. To increase the population, the policy of assisted settlement is at present being pursued, and yet, despite widespread unemployment in England, the increase by immigration has become considerably reduced since the War. Better communications are among the outstanding needs of the Commonwealth, and the co-ordination of transport systems, railways, roads, ports and aviation, is essential. Western Australia is, indeed, so cut off from the main centre of life in the Commonwealth, that it felt justified in agitating for secession.

(v) New Zealand

New Zealand was first discovered in 1642 by Tasman and the coast was explored by Captain Cook in 1769. It soon became a resort for whalers and traders, chiefly from Australia. In 1840, the native chiefs were subdued and it became a British colony. The aborigines, the Maoris, belong to the Polynesian races, and had attained a high degree of civilization of their own and have largely blended with the general population. In 1907, New Zealand was constituted a Dominion.

Production and trade. New Zealand is about 1,200 miles east of Australia, and is an isolated group of islands the chief of which are the North and South Islands. The population is about 1,550,000, of whom about 75,000 are Maoris. The principal occupation in the country is agriculture ; the chief exports, therefore, are wool, meat, butter, cheese, hides and skins. Isolation in the Pacific is a determining factor in the economy of the country, and explains the great dependence of New Zealand on markets in distant countries, chiefly Britain. Exports of agricultural produce is the dominating feature of economic life ; fresh and favourable markets have to be constantly secured and the Government is continually striving to bring about adjustments between the interests of protected and over-capitalized industry and those of agricultural producers seeking markets for their surplus. From the point of view of the farmer, an increase of population is desirable, and the industrialist favours cheap labour ; and the problem of assisted immigration assumes importance inasmuch as the immigration of Asiatics is considered undesirable for a white New Zealand policy.

Mandatory power. In 1923, the Ross and Victoria areas of the Antarctic Continent were placed under New Zealand as the Ross Dependency ; this is a distant possession of doubtful value. As a result of the World War, the mandate for Western Samoa, which formerly belonged to Germany, has been given to New Zealand. Nauru Island, about 26 miles south of the equator, was annexed by Germany in 1888, but has now been placed under Great Britain as the mandatory power. It has rich phosphate deposits ; and New Zealand, Australia and Great Britain, all being interested in these, the island is governed by an Australian Commissioner who sees that the phosphate production is properly distributed.

Problems. The isolated position, small population, restricted immigration and scattered possessions from the equator to the south pole, are handicaps in the progress of New Zealand, which, however, assumes an importance in the Pacific problem. Singapore now arouses considerable interest among the New Zealanders, who follow with great interest the trend of British policy in China and Japan, and the Pacific generally.

(vi) Egypt

Egypt is a country having great length but little breadth. The triangular delta, lower Egypt, is the most densely peopled part of the land, and only about 80,000 out of a population of 13,000,000 live outside the delta and valley of the Nile. Like India, it is a land of very small holdings, and the poor peasants are known as the fellahin.

The Nile. The life of Egypt is bound up with the Nile and its waters ; with the pressure of an increasing population, and with no industries of any note, extension of the cultivated area by increasing the irrigation facilities has become a necessity. Attention has therefore been increasingly centred upon the Upper Nile, which flows through the Sudan, Uganda and other British possessions. This creates for Egypt a position of dependence upon Britain. The Nile has been regarded as of prime concern to Egypt on account of her large population and ancient civilization. The Sudan on the other hand, under British control, offers a fair field for capital investments and produces high grade cotton suitable for the Lancashire textile industry. Throughout the Anglo-Egyptian negotiations, the British held fast to the view that they were the guardians of the Nile. The division of water between Egypt and the Sudan was a matter for discussion at conferences, but the claims of Egypt to sovereignty of the Sudan, or for the recognition of its water rights in Uganda have never been accepted. To Egypt, the Nile waters mean principally food; to the Sudan, with only about 3,000,000 of people, they represent possibilities of rapid development of cotton production. The Makwar barrage near Sennar on the Blue Nile irrigates the Gezira region and diminishes the amount of water available for the Aswan Dam in Egypt. Settlement of the lines on which irrigation should be developed in the Sudan without harming the just interests of Egypt thus furnishes a problem of considerable difficulty in Anglo-Egyptian relations.

The Suez Canal. But a far more important problem between the two countries is the one of control of the Suez Canal. The control of Egypt by Britain is indeed essential for the security of the Canal zone and of the Empire's main line of communication to the Indian Ocean. Thus independence cannot be conceded to Egypt by Britain, except with reservations. A similar problem faces the United States with respect to the State of Panama and even to the Philippines, which occupy a position of great strategic importance with respect to the Far East.

Anglo-Egyptian relations. Egypt was a Turkish dominion for a long time after its conquest by the Turks in 1517, the Khedive acknowledging the Sultan of Turkey as his suzerain. The strategic position of Egypt was recognized by Napoleon and the British even before the construction of the Suez Canal;

but the canal very greatly increased its importance to Great Britain. The Turkish control was but nominal. The Khedive having sold out his shares in the Suez Canal Company to the British, the British and French established a dual control, a *condominium*. But Great Britain constituted itself as 'adviser' to the Egyptian Government after the rebellion of Arabi Pasha, and on the outbreak of the great World War, Egypt and the Sudan were annexed to the British Empire as a Protectorate. The Protectorate was abolished in 1922 and a measure of independence was granted to Egypt, with reservations in favour of Great Britain. These provided for British control of the Nile waters and an army of occupation in Egypt, and the exclusion of foreign influence. The recent Italian conquest of Ethiopia brought the two countries nearer to the solution of their problems. Egypt realized the value of British protection against external aggression, threatened by the growing girdle of Italian influence. Britain saw the wisdom of having a contented and friendly Egypt; and in a recent treaty, the independence of Egypt is recognized, Britain undertaking to withdraw its army gradually to the Canal zone, and Britain conceded the Egyptian claim to a dual control, a *condominium*. Thus Anglo-Egyptian relations are today more friendly than ever before, though their problems do not seem to have been finally solved.

(vii) Palestine

Though Christianity and Judaism had their original home in Palestine, the population is largely composed of Arabs with a few Druses, Turks and Jews. It is a tiny country. It has a population of about 1,000,000, less than that of the city of Bombay or of Calcutta. Yet this tiny land has sent out a mighty force, that of Christianity, whose spiritual message has reached every part of the civilized world and it was this **least of all lands** that inspired the Crusades of the Middle Ages. Palestine has always been subjected to foreign influence. From the vast inland regions of Asia came mighty caravans and armies; the Egyptians and Turks passed up and down its Mediterranean coasts; but it was the plateau of Judea that enabled it to retain its individuality.

A Zionist state. Palestine interests the world today for the experiment that is being carried on there for the creation of a Zionist state. It is the natural homeland of the Jews; yet it is not proposed to start a great return movement of Jews towards Palestine, for the small land could not maintain them all. To hand over the government to the Jews with an Arab majority in the country would have meant disaster. A strong western power, England, was therefore given the mandate. Under British influence, the Jewish population has more than doubled; in 1925, more than 30,000 Jews immigrated to Palestine, chiefly from Poland, Russia and Romania. The Jews are inclined to congregate in cities and do not take kindly to agriculture. They have an elected Jewish National Assembly which appoints a Jewish National Council. They are aggressive, desire to push the Arab aside, and make nationalism the dominant issue. The Arabs hold that such an arrangement means a Government within a Government, and have broken out in revolt to end this intolerable situation. Some of the Jews regard Palestine as an experiment and perhaps as a centre of Jewish influence which might be of material assistance in finding solutions for the problems of Jews in Europe.

Great Britain and Palestine. England is particularly interested in Palestine for several reasons. The control of the Suez Canal area is vital to the safety of the British route to India, Africa, the Far East and Australia; and England is therefore concerned in the maintenance of peace and order among the Arab tribes inhabiting the areas adjoining Palestine on the east and south. The new treaty with Egypt makes control over Palestine all the more essential, and the unsuitability of Malta for the defence of British interests in the eastern Mediterranean is leading Britain to consolidate its influence in Cyprus and in Palestine, a plan which would also provide it with an excellent air base. Britain, during and after the War, has consistently advocated a Jewish national home in Palestine, so that it can rely more on the friendly and rich Jews, than on the disorderly, unruly Arabs, whose Islamic leanings towards Turkey or Egypt might become a possible danger. The present troubles in Palestine are therefore being handled with tact and caution by Britain which appointed a Commission to investigate the Arab-Jew question and suggest a suitable settlement. The report of this

Commission, suggesting the partition of Palestine between the Arabs and the Jews, with the reservation of a small coastal tract under Britain, has been received by the population with great dissatisfaction, and a peaceful settlement of the problem is still not in sight.

(viii) Iraq

The population of Iraq, about 2,900,000 is distinctly homogeneous. The Arabs are the predominating element in the population, and abandoning their once nomadic habits, they have settled down in the river valleys to cultivate the soil. Iraq is a small and poor country. Agriculture is confined to regions where there are irrigation facilities, upon the flood plains and lower terraces of the Tigris and Shat-el-Arab, while extensive pastoral lands yield wool, hides and skins. The soil is extraordinarily fertile, and with the restoration of the ancient system of canals and drains, whereby the water of the Euphrates would be used to irrigate the land west of the Tigris and the Tigris water utilized for eastern lands, Iraq would become an important agricultural land. It produces large quantities of dates; but it could easily be made to produce a large amount of cotton. For the present, however, Iraq has its chief wealth centred in the expansion of trade and in the development of its oil resources.

Oil resources. The production of oil at present is comparatively small, but the possibilities are great; and this is a matter of vital concern to Great Britain, whose navy and mercantile marine make an increasing use of oil for fuel. The Mesopotamian oil-fields aroused rivalries between Germany, the Netherlands and Great Britain before the World War. The region belonged politically to Turkey, but Germany had already made preliminary surveys of the oil resources there, while Great Britain had already secured vantage ground by the exploitation of the Persian oil resources through the Anglo-Persian Oil Company. After the War, an arrangement was arrived at, under which Britain and the United States each hold a 25 per cent share in the Turkish Petroleum Company, while France and the Netherlands share 25 per cent between them.

Progress. Since 1928, Iraq has been set up as an independent Arab kingdom, though under British influence. Its transport system includes river navigation which serves a large part of the population; railways which need only two short connexions, one from Kirkuk on the south and another on the west, to make at least one complete trunk line system; and aeroplanes. Besides these, a number of motor roads have been built, notably the one which connects Baghdad with Damascus, and there is a regular trans-desert automobile service between Baghdad and Beirut. The chief interest that Great Britain has in Iraq is due to its great oil resources and to the fact that it flanks Great Britain's land route to India, whose real frontier is practically on the Persian Gulf rather than on the western border of Baluchistan. Hence Britain cannot afford to loosen its control on Iraq, for a freed Iraq might become part of a general confederation of Arab states. British influence has led to greater efficiency of administration, the encouragement of agriculture and the development of railway transport. Pan-Islamism which would be the natural driving force from Afghanistan to Morocco is thus checked by British control over Iraq, Palestine, Transjordania, Egypt, and the Anglo-Egyptian Sudan, and French control over Syria and the southern shores of the Mediterranean.

(ix) Kenya

Kenya Colony has been a Crown Colony since 1920, and the Kenya Protectorate includes the territories on the coast rented from the Sultan of Zanzibar. Its area is about 225,000 square miles and the population is about 3,100,000, including 17,000 Europeans, 38,000 Asiatics and 12,000 Arabs. On the coast, the Arabs and Swahilis predominate; farther inland are races speaking Bantu languages. The Legislative Council recognizes the various interests in the Colony by having eleven elected European members, five elected Indian members and one nominated unofficial member to represent Arab interests.

Production. Agriculture is possible from sea level to altitudes of over 9,000 feet. Climatic conditions are extremely varied, and tropical, sub-tropical and temperate crops are grown. The main producing areas are in the highlands where coffee, maize, wheat, sisal and tea are crops of major importance. At lower altitudes where conditions are tropical, sugar, coco-nuts and cotton are the principal crops. The forest area is extensive and olive and valuable hard-woods like camphor grow well. Pencil cedar is also important. The mineral resources are not yet fully explored.

Trade. Kenya Colony and Protectorate with Uganda and Tanganyika (originally German East Africa) form a customs' union. Among the chief exports of the region are cotton and coffee, while a peculiar export is ivory. The chief trade is with Great Britain, India and other British possessions.

Importance to Great Britain. The chief interest of Great Britain in East Africa lies in the fact that, with Egypt and the Anglo-Egyptian Sudan, it forms a broad strip stretching north to south with the Mediterranean at one end and the Indian Ocean at the other, and with Tanganyika territory under British mandate, connects up with British possessions in South Africa, thus looking out on the Southern Ocean also. It flanks the route to India, and control of it has brought the Cape to Cairo railway project within the bounds of practicability and has made the Cape to Cairo airway a reality. The chief problem in that region is therefore the control of Tanganyika on the one hand, and the solution of the Indian problem within the territories on the other. Kenya also affords an experiment in tropical colonization by a white people.

Zanzibar. Zanzibar is a small island protectorate which includes also the island of Pemba. It was in 1890 that France and Germany recognized the supremacy of British interests in these islands in return for the recognition of similar French interests in Madagascar and the cession of Heligoland to Germany. This last became a source of great trouble to Great Britain in the World War when that little island, strongly fortified, became the chief base of operations for the German navy and a guardian of the Kiel Canal. British policy in relation to India and South Africa makes it necessary to retain control of Zanzibar and Pemba, while to India they are of interest for the 14,000 Indians through whose hands almost the whole trade of East Africa passes. The clove industry is by far the most important industry, supplying the bulk of the world's requirements, and recent regulation of the industry by legislation has been viewed with considerable alarm by Indian merchants, who feel their interests to be seriously menaced.

(x) Ceylon

Ceylon was separated from India and formed into a Crown Colony in 1802. The administration was liberalized in 1931, seven out of ten ministers being elected members of the State Council, and the territorial franchise being extended to adults of both sexes. The total population of the island is a little over 5,300,000 of whom the Tamils of south India, numbering about 800,000, form about 15 per cent. Tea is the most important export with copra and coco-nut oil and rubber following. Among the peculiar products of Ceylon, mention must be made of plumbago and gem stones—sapphires, rubies, moonstones, cat's-eyes, etc. Ceylon is important to Great Britain as a strategic centre for the defence of India and for the security of her route to the Far East and to Australia; and Colombo has rightly been called the letter-box of the East. The Indian Ocean has become a British lake and that lake is guarded on the north by the three great strategic centres—Aden, Ceylon and Singapore. While Ceylon is geographically a part of India, having been connected with it by a land bridge at one time, politically it has been separated, so that whatever relaxation of control Great Britain might find it desirable to introduce in its relation to India, Ceylon as a Crown Colony, would, apart from its valuable exports of tea and rubber, be a very vital link in the chain of British strategical centres on the route to the Far East and in the Indian Ocean. To India, Ceylon is obviously important as a neighbour with which commercial relations could be better developed and which might furnish her with a field for immigration.

(xi) Burma

This country, so long a part of the Indian Empire, is now being separated from it and set up as a separate dependency, with a constitution liberalized to a very large extent. With the advance of India on the road to Dominion Status and self-government, Burma is being separated with a less advanced constitution, in spite of the protests and representations of India and the Indian community in Burma.

The area of the country is 2,600,000 square miles and the population is 14,700,000. The first Burmese War gave Arakan and Tenasserim to the British as early as 1826; in

1852 Pegu was annexed by Lord Dalhousie, and in 1886 Upper Burma was annexed. In 1897 the whole of Burma was placed under a Lieutenant-Governor under the jurisdiction of the Indian Empire, and in 1923 it was made a Governor's Province. The Burmans belong to the Tibetan group and are Buddhists.

The great artery of trade is the Irrawaddy, navigable for 900 miles from the sea up to Bhamo near the Chinese-Yunnan frontier, and its tributary the Chindwin which is navigable for 300 miles. The railway mileage is a little over 2,000 miles. The sea-borne trade of Burma has a value of about 31 crores of rupees. The characteristic products of Burma are rice, teak and oil ; tin, tungsten ore and silver are also important.

Importance to Great Britain. The long incorporation of Burma in the Indian Empire has attracted many Indians to the country. These play a very important part in its trade, and their vested interests demand recognition. On the other hand, the interest that Great Britain has in Burma centres round three facts. Firstly, Burma is a large producer of oil which is becoming so vitally important for war, transport and industries. Secondly, in view of the weakening control of Britain over India, Burma becomes an important strategical area, particularly for the sea route to the Far East through the Strait of Malacca via Penang and Singapore. Thirdly, the country becomes vital to the prosecution of British policy in China. With the determined intrusion of Japan in north China, Great Britain's interests increase in Yunnan and southern China, with its huge population and great resources. The establishment of British influence in Tibet and the investigation of the Sino-Burmese frontiers in the Bhamo-Yunnan area are expressions of these developing interests of Britain in China as a market and a source of raw materials. Under these circumstances no weakening of British control over Burma is conceivable.

5. THE UNITED STATES OF AMERICA

This great country has achieved strikingly rapid progress during the last half century, and while maintaining its Monroe Doctrine for excluding European interference in the Americas, has increasingly interested itself in international problems, so that it has a very strong influence in the councils of the world. Although the United States is not a member of the League of Nations, it was its President, Woodrow Wilson, who originally inspired the League and infused into it the breath of life ; and indirectly the United States materially influences the League.

Rapid development. Its vast size, great variety of climates, fertile soils, extensive mineral deposits, enormous natural resources and excellent waterways give to it a vast variety of products, agricultural, pastoral, mineral and manufactured, which form the basis of its enormous foreign trade. Its people are largely of European stock, and though England, Ireland and Germany have contributed very considerably, other European countries, too, have sent out their contingents of immigrants to this great country of the New World, which to Europe, the 'Continent of Achievements', appears as a 'Land of Opportunity and Possibilities', so that the United States has built up the edifice of its progress and civilization on the foundations of European experience. Efficiency of labour, inventiveness, scientific management, efficient railway organization, labour-saving devices, standardization of parts, trusts and big business are remarkable characteristics of American industries which, under the protection of century-long tariff walls, have flourished so well as seriously to invade the preserves of several industrial countries of Europe. The leading producer of iron and steel, it also leads in the production of mineral oil ; it is important for coal and gold, for silver and quicksilver, for wheat and meat, for cotton and wool.

Internal expansion. The history of the progress of the United States in the nineteenth century consisted largely in a westward expansion. The Atlantic coast was the first to be developed with manufactures in the north-east and agriculture in the south-east; next came the great plains of the Mississippi-Missouri, important for agriculture and cattle-rearing ; the centre of advance went farther west to the Great Plateau rich in minerals ; and now the Pacific coast is developing fast, so that, starting from the Atlantic, the United States is now looking on the Pacific. The internal expansion having ended, for further expansion, political or economic, it looks out to the Far West across the Pacific, where its horizon blends with the Far Eastern horizon of the European countries. This brings

China and Japan into effective limelight, and creates a world problem of the first magnitude. The construction of the Panama Canal was a clear recognition of the dawning of this new stage in American development, which, built upon the experiences of the East, secures its communications in the broad Pacific to extend its development in the West.

Population and trade. The population is about 122·8 millions of which 108·9 millions are whites, 11·9 millions are Negroes and 2,000,000 belong to other races. Of these 2,000,000, about 1,400,000 are Mexicans, 300,000 are Indians, 150,000 are Japanese and 75,000 are Chinese. The imports of merchandise of the United States in 1934 amounted to 1,655 million dollars and the exports to 2,133·4 million dollars. The exports are about evenly distributed between manufactures and raw materials, while the imports of raw materials exceed those of finished manufactures. Its exports are largely to Great Britain, Canada, Japan, Germany and France, while its imports are chiefly from Canada, Japan and Great Britain. This large trade is carried in vessels of which about 37 per cent are American and the rest foreign, British predominating.

The population problem. The cultivable lands of America are by now almost entirely occupied; making additional lands available for agriculture by the reclamation of swamp, forest and desert is a doubtful economic proposition because of its expensiveness. Improvement of land and increase of agricultural production can only be secured through intensive methods which will need cheaper labour or wider foreign markets. The population problem, hitherto largely a regional one, is now a national one; the West no longer offers a solution for the relief of the over-populated East; and a large stream of immigrant population from other countries is no longer desirable. The mechanization of agriculture might lead to an increased yield of crops, but that offers a temporary solution only. Intensive and mechanized agriculture will have to be correlated with a lower standard of living, unless the United States can secure wider foreign markets in competition with European nations. So long as agriculture predominated, and until industrial and commercial developments overshadowed it, the United States was more or less an isolated country and did not acutely feel the need for distant markets and raw materials. But since the beginning of the century, the United States has become a great commercial country, and the population problem has become much more important.

The early immigrants into America came mostly from northern Europe; later on, large numbers came from southern and south-eastern Europe. The relative inferiority in education and character of the population of this origin is regarded as likely to weaken the American national character. With the continued industrialization of the United States, the immigrant labour was rapidly absorbed; but the World War revealed the fact that under abnormal conditions when the forces of destruction were let loose all over the world, the pull of the homeland on the immigrant was powerful enough to prevent complete national unity in the United States. A restrictive immigration policy has therefore been followed, and immigration laws limit immigration from a country to two per cent of the total number from that country established in the United States since 1890. This restriction of numbers does not, however, apply to the countries of North, Central and South America. The present policy is to allow immigration only so far as the country can absorb and usefully employ the incoming people.

Negro problem. One of the most important problems in connexion with the population of the United States is the Negro question. In the north, the Negro lives in poor and unhealthy quarters with increasing ill-feeling and friction between black and white; in the south, the number is large and the intermixture of the races goes on at a rapid pace. Continued industrial development demands cheap labour which, because of the restrictive immigration policy, can be met by the southern Negroes; but such urbanization of the Negro leads to a higher death rate, so that with the immigration of the whites and their natural increase, the percentage of the Negro population to the total will, it is presumed, be lowered markedly in about another fifty years. The Negro has had to bear many handicaps. The slave-trader brought him to America against his will; the American Civil War brought him emancipation through practically no effort of his own; circumstances gave him a place in the political and economic organization of the land for which he was not fitted. Racial antipathy is acute and increasing. But the United States has no solution of the Negro problem except in the hope that the numbers will become relatively less important in course of time.

Expansion in America. Peace on the **unguarded boundary** of 5,400 miles, free intercourse of the people and development of business interests have characterized the relations of the United States with Canada. On the Latin American border, expansion was brought about by a war with Mexico resulting in conquest of certain areas. Alaska was acquired in 1867; but the greatest developments were toward the tropics. The Philippines were acquired and supremacy was secured in Cuba; Porto Rico was acquired with the Canal zone and so gave to the United States the control of the Panama Canal. The Virgin Islands were purchased from Denmark in 1917. American influence has been felt in South America and Central America, in all directions, in mining centres, oil-fields and public service. The economic ascendancy of the United States in the West Indies was considerable even before the Spanish War in 1898; but the movement was greatly quickened by that war, so that today the United States has developed very close political relations with the West Indian islands, because of its large and extensive investments there and its policy of naval defence.

The Philippines. The Philippines constitute a major problem of the United States. The Filipinos have shown a remarkable capacity for self-government, and the United States has deliberately encouraged the development of that capacity since the islands were acquired. American commercial advance in the Philippines has been the result not of colonization or settlement, but of the flow of capital and the introduction of American business organization, particularly after free trade was established between them. It is these American economic interests that make the problem of progressive self-government and independence for the Filipino almost insoluble. The situation of the Philippines is peculiar in that while it is near enough to China and Japan, it is far distant from America and American possessions. Formosa, which belongs to Japan, is hardly 100 miles from the northern islands; China is 500 miles from Luzon; Manila to Hong-Kong is about 640 miles; but the nearest American possession is Guam, 1,500 miles away;

the Hawaiian Islands are about 3,000 miles and San Francisco, the chief Pacific port of the United States, about 7,000 miles from Manila. The American possessions in the Pacific are few and scattered, lying in a chain across the Ocean with the Philippines the most important of all at the farther end, very close to the Far Eastern powers. The affairs in the Philippines interest Japan and China, the Netherlands and Great Britain. In this area, there are quite a number of possessions belonging to these and other powers with conflicting interests. The Philippines are rich and have a population of more than 10,000,000 ; their products are complementary to those of the United States, and trade with them benefits America ; and in case of war, they would be a useful base of operations. The United States has but little confidence in the goodwill of Japan ; there has been a conflict of views upon the policy of the open door in China, and over the penetration of Japanese influence in Manchukuo and its rapid southward rush to the regions of Jehol and northern China. To defend the Philippines in time of war against a first class power like Japan would be a task with a doubtful result, unless the United States was prepared to incur heavy expenditure, initial and recurring.

The United States cannot today be regarded as in any way maintaining an attitude of isolation, avoiding entanglements and commitments by alliances or otherwise, or by adherence to the Monroe Doctrine as a definite part of its foreign policy. By the end of the nineteenth century, it was involved in the affairs of Samoa, Tangier and Liberia. Its relations with Japan have been strained because of the latter country's definite policy in China. The Washington Conference itself was the result of a difficult situation, which involved the European powers and Japan. American interests and interference in international problems is increasing, particularly in the problems of the Pacific and the Far East.

6. UNION OF SOCIALIST SOVIET REPUBLICS

Russia

Russia is a sub-continent of vast proportions, a giant among European countries. It is half the size of the United States and is a little smaller than British India. It is a land of extensive plains, vast forests, great lakes, wide marshes and large rivers. The Russian expansion in Asia increased its territories considerably and the whole area under the Soviet Union now is more than 8,200,000 square miles, with a population of about 165,800,000. In March 1917, the Russian revolution broke out, leading to the overthrow of the Czar, Nicholas II, and the setting up of a provisional government, which in turn gave place to the present Union of Socialist Soviet Republics consisting of seven Republics, namely, the Russian Socialist Federal Soviet Republic with Moscow as headquarters (R.S.F.S.R.), the Ukraine, White Russia, the Transcaucasian Federation, Uzbek, Turkman and Tajikistan.

Great resources. The geographical environment is, without doubt, very favourable to Russia in many ways ; its resources are great ; its extensive fertile lowlands with a dense population of peasants, its large export trade in food-stuffs and raw materials, its possibilities of much greater production are all elements of strength. But mere area does not beget prosperity and progress, and resources remain mere possibilities until they are developed by an efficient economic system. Over such a vast area as 8,200,000 square miles, the railway mileage is only 45,000 miles. The waterways of European Russia add 20,000 miles, while Asiatic Russia adds another 20,000 miles suitable for steamer navigation. The greatest forests in the world are not significant because there are no railroads to transport forest products and because the rivers are navigable only for three months out of twelve, and flow towards an ice-bound sea. The large areas of eastern Siberia are not of much use because they are so far distant as to be mixed up more in the problems of the Far East than of Europe. A large percentage of Russia's population is backward nomads, fishermen and hunters. Illiteracy was till recently a prominent feature, even among the Russians themselves. Great resources remain mere possibilities until they are actively developed and utilized. Diversity of geographical conditions is a great asset only if various resources, such as forests, soils, fisheries and minerals are close enough to be interrelated with one another and with consuming centres and markets. The transport of the wheat and butter of Siberia and the dried fruits of Turkestan to western Europe is a difficult problem. Cotton, a crop of growing importance in the irrigated lands of Transcaspia, has an increasing acreage and the greatest need of Russia has been transport and an outlet on the open seas.

Progress. The introduction of the Soviet system is one of the most outstanding experiments in the history of the modern world. It has adopted communistic principles of state ownership of all resources such as land and industry, houses and forests. The industrial workers residing in compact areas in towns, lend themselves more readily to organization and propaganda and are exploited under the Soviet system for political purposes. They have been established upon the large estates of the nationalized land, private trading has been abolished, and the foreign trade of the U.S.S.R. has been organized as a state monopoly. Industries are administered by state trusts and combines, numbering about 600, of which 291 are big trusts. A small number of trusts, the monopoly trusts such as the Rubber Trust, Silk Trust, Urals Asbestos Trust, combine all the enterprises of a given branch of industry in the whole Union. Imports and exports are regulated by special licences issued by the Commissariat for Foreign Trade in pursuance of a plan annually sanctioned by the Government. The right of purchasing goods for importation and that of selling Russian exports abroad is vested in the Trade Delegations of the U.S.S.R. in foreign countries; and by special decrees, state and co-operative organizations are selected and authorized under the control of the Trade Delegation to engage in foreign trade. Foreign capital for participation in the foreign trade is encouraged by the formation of **mixed companies** in which shares are held by the Soviet Government and foreign concerns. The Centrosoyus, Selskosoyus and several other co-operative organizations have been granted the right of **exit to the foreign markets.** Russia, under its **system of planned economy,** which is being copied elsewhere, has thus worked tremendous changes. Education has been made obligatory, and illiteracy is a matter more of the past than of the present; new towns have been brought into existence in the new industrial regions; the industrial production rose in 1933 to 70 per cent of the value of all productions, so that the Soviet Union is now more industrial than agricultural.

Trade. The exports in 1933 amounted to 496 million roubles, metallurgical and other industrial products predominating; the imports to 348 million roubles, ores, metals, and machinery being the most important. Germany is the principal country for Russian imports, while it shares the first place with Great Britain in the matter of exports. The mercantile marine now totals over a million gross tons, and railway construction is being pushed forward.

Outlet to the sea. With the fall of Czardom and the introduction of communistic principles it was supposed that internal problems would naturally engross the attention of the state, and that territorial expansion would no longer occupy its energies. But the world has, by now, realized that Soviet Russia has not departed from the purpose of Czarist Russia in the matter of the expansion of its frontiers. The great historic aim of Russia has, for centuries, been access to the sea, and particularly to ice-free water, and this largely explains the course of the history of that country. From the beginning of the sixteenth century Russia was trying to discover and open up a northern route to Europe by way of the White Sea, and to establish its position on the Baltic. The vast lowlands and featureless plains of Russia did not satisfy the Russian people, and they extended their control in a southerly direction to the Euxine or Black Sea and created outlets on the Baltic and the Arctic shores. Under Peter the Great, Russia first reached a position of power and importance as an empire; by his victories, he extended Russia's dominions and consolidated its position firmly upon the Baltic coast. In the eastward direction, Russian fur traders first reached the Pacific in 1639, and the seventeenth and eighteenth centuries may be regarded as the era of Russian exploration and settlement in Siberia. Russia's eastern expansion and development is a striking historic fact. Originally an Asiatic power pushing forward westwards in Europe, Russia is now a European power establishing its position in Asia.

Russia's desire for access to warm waters was not satisfied by the possession of Archangel, St. Petersburg or Riga; and even from Odessa, the Ukrainian port on the Black Sea, routes lead to the Mediterranean only through the Bosporus and the Dardanelles, straits controlled by Constantinople. Designs on Constantinople were therefore the key-note of Russian policy throughout the nineteenth century, and this explains its machinations resulting in the dismemberment of the Turkish Empire by the gradual secession of Greece, Albania, Bosnia and Herzegovina, Serbia, Montenegro, Bulgaria and Romania; and in the Crimean War, when England and France, however, frustrated this design by joining the Turks against Russia. The World War left Russia isolated from its great allies, England and France, because the frozen Arctic, the German control of the Baltic, and the Turkish control of the outlet from the Black Sea to the Mediterranean, made it impossible for them to render Russia any effective aid. So urgent became the need for establishing contact, that England had to undertake the extremely difficult task of forcing the Dardanelles. The expedition succeeded in forcing a landing, but failed to make any headway and had to be abandoned, and though the Allies ultimately won the War, the Russian revolution prevented Russia from being a sharer in the spoils of the War, and perhaps getting a foothold in Constantinople. An alternative outlet that Russia sought was one on the Persian Gulf, and with that aim it has always desired to establish cordial relations with Iran, the northern part of which came to be recognized as the Russian sphere of influence, though the wary British established their sphere of influence in the south on the Persian Gulf. Foiled in this purpose, the great octopus of the north threw out a tentacle through Transcaspia towards India and the Arabian Sea ; and the last quarter of the last century witnessed the spread of Russophobia among the military authorities of British India. The security of the Indian border was attained through the strengthening of the frontier defences and through subsidizing the friendly buffer state of Afghanistan. The tentacle then went out definitely eastwards and Russia concentrated on pushing its way through Mongolia, Manchuria and China to the Pacific.

After the World War. Russia finds itself at present in a peculiar position on its western border. New or enlarged independent states stretch in a chain from the Arctic in the north to the Black Sea in the south, and owe their position largely to the protection and support of England and France. Poland and Romania receive guidance and help from France ; the Baltic states are of special economic importance to England.

But Russia waits for a favourable opportunity to regain its former outlets on the Baltic, and establish its control over Bessarabia which has been given to Romania. But in contrast to its policy on the Baltic front, Russia strove successfully to maintain its power over the Ukraine, and prevent this from constituting itself as an independent state, since that would have blocked up its access to the sea even more completely than ever. A large part of the population of Turkestan, and the regions to the east of the Volga and on the Black Sea shores are Mohammedans whose ethnic affinities draw them towards the important Mohammedan states. Armenia and Georgia strove to secure independence. A Turkestan federation was at one time projected. The Don Cossacks, the Kubans and the Ukrainians conceived the idea of a Black Sea Federation, and a Far Eastern Republic in Siberia was actually established for some time. Georgia desired independence so as to secure to itself the full benefit of the exploitation of its important manganese deposits, and the Tartars of Azerbaijan similarly wished to secure special profit through the exploitation of the oil resources of the Baku region. These separatist tendencies would have led to fragmentation and weakness. But railways and telegraphs enabled the Moscow Government to maintain easy and quick communications and move troops rapidly, and thus fight these separatist movements successfully while the judicious combination of central control with local autonomy has enabled it to weld into coherence the divergent parts of the vast lands of Russia.

Eastward expansion. The eastward expansion of Russia was brought about, not as a result of the activities of explorers, but by force of arms and by subsequent colonization. By 1630, the Russians had established themselves on the Yenisei; by 1643, they reached Lake Baikal and by 1656 the Bering Sea. Armed clashes with the Chinese for the possession of the Amur basin ended ultimately in 1858 by Russia making the Amur the boundary between the two Empires. The Russian is readily adaptable to new conditions; he has been able to take to agriculture, cattle-breeding, or trade as readily as to hunting or fishing, while maintaining his characteristic community organization; and he therefore makes not only a successful explorer and colonist, but a valuable empire-builder.

The stream of colonists was checked during the War and thereafter, but it has begun to flow again, directed by a central colonization bureau at Moscow. In the development of western Siberia, it is not so much the long main line of the Trans-Siberian Railway as the branch lines reaching out to north and south that are of special significance. Western Siberia has no direct outlet to a commercially useful sea, and the dominating thought of the colonists has been to obtain a shorter and cheaper route to markets than the Ob river route to the Arctic, which is open for only two months of the year.

Soviet Russia has resumed the old policies and aims of Russia and has increased pressure on Mongolia and Manchuria, but is faced with the determined aggressiveness of Japan. From Transcaspian regions also, Russian influences have penetrated to Sinkiang where they are likely to come into conflict with British-Indian interests. Its Far Eastern policy with regard to China will at no distant date draw it into conflict with Japan, and might even precipitate a world crisis.

7. FRANCE

Progress. France with an area of over 200,000 square miles, has a population of over 41,800,000. France is peculiar in having an almost stationary population, and no temporary expedients for encouraging the growth of population can have permanent results, for the idea of limiting the size of families is deep-seated, though that involves the limitation of population and national strength. It has vast colonial possessions next only to those of Great Britain, but these are widely scattered and of unequal value. Some, like Madagascar, are important for their large native populations and resources; others, like New Caledonia, for their strategic position and special mineral or vegetable products; still others, like Indo-China, as extensive trade areas of growing consequence. But the two important areas that claim attention are Syria and North Africa; and France is, after all, primarily an African power. It has built up large trade, the imports being 23,061 million francs and the exports 17,822 million francs in 1934. Manufactures dominate the exports, and raw materials and food products, the imports. Among the leading exports are iron and steel and chemical products, followed by cotton, silks, automobiles and wine; while the chief imports are coal and oil, wine, wool and cotton, cereals and oil seeds. The colonies are most important for French trade, and next to these are Germany, Belgium, Great Britain, the United States and Switzerland. The railway mileage in 1933 was over 26,000 miles; French tonnage in its carrying trade is about 27 per cent.

Relations with Germany. France has the sea on three sides and land on the east and the south-west. This tends to make France both a land power and sea power with the result that it has failed to be absolutely first rate in either, European complications interfering with its colonial expansionist policies. Though, like England, almost central in the land hemisphere, it lost to that country in the colonial race and had ultimately to accept the second place. The rise of the United States does not trouble it much since that vast country was following a policy of domestic internal expansion, and has entered the field of world-wide competitive enterprise only recently. But the rise of Germany affects France very vitally indeed. France is naturally a strong advocate of peace and the resultant security; and in the 60,000,000 of the German population and its higher rate of increase, as against its 40,000,000 and a stationary population, France is faced with the conclusion that she will probably become second to Germany in material and political power as well as in population. To stave off this undesirable contingency France, like England, is a staunch exponent of **collective security** and alliances. The national desire of the French to secure recognition by the world of the historic power and glory of French arms is a factor in the issue. After the great World War, France had to accept three main disappointments. The damage done by Germany could not be paid for; France had to give up one of its most fundamental and strategic aims, a Rhine frontier, under pressure from Great Britain and the United States; Germany did not make any reparation payments to France. Failing to provide against possible German aggression in this manner, France has steadily followed the policy of alliances in eastern Europe, which might be effective in restraining turbulence and truculence in times of peace and in rendering assistance in times of war. It has entered into treaties with Czechoslovakia and Poland, and with Yugoslavia and Romania, so that with the recent Franco-Soviet pact, it has built up a chain of alliances from the Baltic to the Mediterranean and Black seas.

Improvements. France has developed its industrial and technical equipment. Port installations, harbours and waterways have been considerably improved, and the mercantile marine shows a rapid increase in tonnage. The organization of industries has been improved, and horizontal and vertical combinations have infused new vigour and strength into French industry—metallurgical, chemical and textile. Technical education, though it has for many years reached a high stage, has been further improved. The element of stability in French life has been its agricultural population, and France is almost self-sufficient in respect of its food-supply. The advancing industries require more man-power, and immigration of labour has been a very marked feature in French industrial organization. Of the 2,500,000 foreigners in France in 1926, 800,000 were Italians, 470,000 Spaniards, 460,000 Belgians, 300,000 Poles and 140,000 Swiss. The Russians are about 100,000, the British about 84,000, the Germans about 65,000, and the Czechoslovaks about 40,000. The present is a critical period in the growth of population in France, which will now experience the effects of the heavy fall in the birth-rate during the period of the Great War.

The Franco-German frontier. Alsace-Lorraine presents a special problem to France. The return of these two provinces to France has added about 2,000,000 to her population. It has added to her mineral resources particularly in iron ores, so that France is now a great producer of iron and steel. While Lorraine is important for iron, Alsace has oil wells, great potash deposits and great agricultural production. The great majority of the population of Alsace is German, but that is not the case with Lorraine, though the language is largely German. Situated in the transition zone between the Celtic and the Teutonic civilizations, **the Rhineland,** of which these provinces form a part, has developed a culture of its own, and the Alsatian is therefore an Alsatian first and foremost. The Rhine is the natural frontier between France and Germany; but the Franco-Prussian War pushed France back from the Rhine. The World War took it once more to the Rhineland. The little duchy of **Luxembourg** has great strategic importance and though not now in the French or the German customs' union, it has joined Belgium in an economic union since 1921. Its rulers are of German descent; its railways were financed by Germany; its iron ores are important and it, like Belgium, remains a sort of a buffer-state between Germany and France. The **Saar valley**, consisting essentially of a coal basin, was a tributary to France up to 1935 as compensation for the great damage done by German armies on French mines, but a plebiscite has now restored it to Germany. The Rhineland has recently been occupied by Germany, and the recent declaration of Belgium that she will preserve neutrality brings Germany and France, the two great contestants for power in Europe, face to face, across the Rhine, with Belgium and Luxembourg as buffers, as before the World War.

Syria. Syria, of which France is the mandatory power, is separated from the plains of Anatolia by the Taurus mountains, the most important pass, the Cilician Gates, being under Turkish control. The Amanus mountains form the northern boundary, with a passage through the gap at the Syrian Gates. On the east it is separated from Iraq by a desert which has been crossed for centuries by caravans, but which is now being traversed by aeroplanes, motor-cars and railways. The area is 60,000 square miles and the total population is 2,500,000; two-thirds are Mohammedans, while about 500,000 are Christians and 10,000 Druses. The country stretches north to south and is very narrow, having a width of about 50 to 100 miles from the Mediterranean coast. The chief centres of life are Aleppo and Damascus, each with a population of about 150,000 and Beirut is the chief port. Northern Syria is dry and has a low relief that has attracted the main commercial route from Iran and Iraq to the Mediterranean. Farther south, there is steppe, with fair rain in the west; in southern Syria, are the Lebanon mountains, with their western slopes covered with flourishing orchards, vineyards, farms and gardens.

Syria is an agricultural country; there are few industries and no important minerals. The Syrians are Semites who show a large mixture of peoples from Arabia, Egypt, Greece, Italy and Turkey, and their principal language is Arabic. Among the territories assigned to the various European powers after the Great War, Syria has shown the greatest unrest and caused most trouble to its mandatory power, for, while France claims that it has been the natural protector of Christian peoples in the East since the days of the Crusades, and at the same time seeks to strengthen its traditional claims by urging its financial interests in the country, its railways and silk industry, the Mohammedan population feels ill at ease under French domination and is in a state of chronic unrest. The Syrian leaders are deeply imbued with the idea of the realization of Arab nationalism, and cannot be satisfied, with mere promises of self-government. In spite of the clash of interests and ideals, France maintains its control over Syria as a barrier against the increasing growth of Mohammedan power. The only alternatives to French administration that can possibly be conceived are British or Turkish administration. Great Britain however, has, its hands too full in Egypt, Palestine, Iraq and elsewhere, and Turkish rule is hardly desirable for the Christian population. While an independent Iraq is under the mild control of the British, an independent Hejaz is under Ibn Saud, and an independent Transjordania under Amir Abdulla (though under the mandate of Great Britain), the Syrians aspire to have an independent Syria and with it an Arab Confederation, which, however, neither Great Britain nor France would be willing to favour. The idea of a Zionist state in Palestine was a disappointment to the Syrians, who have set their hearts on full independence without control or interference from foreign powers acting as mandatory powers or otherwise.

France as an African power. France has in Africa very large territories under its control. Excluding Madagascar, the area is about 4,250,000 square miles and the population is over 30,000,000 ; much of this large area is desert land. This leads to distant isolated stations, absence of rivers and adequate water-supply, poor pasture and turbulent tribal people in the French possessions in northern and western Africa. The French occupation of the southern shores of the Mediterranean began in 1830. The chief possession is Algeria with an area of 1,000,000 square miles ; its mountain region with fertile, sheltered valleys, the **tell**, is economically the most important to France, for it produces food-stuffs and raw materials which are very useful to France for its people and for its industries. France extended its occupation from Algeria to Tunisia, whose products were valuable and whose nearness to Algeria and easy accessibility to France increased its economic and strategic importance. The need for better security on the western frontier of Algeria led to the interference of France in the affairs of Morocco, but it was not till the beginning of the present century that France set itself the objective of establishing domination over Morocco. Great Britain, in 1904, recognized France's special position in Morocco in return for the latter's abandonment of its claims in Egypt in favour of Britain. Spain was recognized by France as supreme in the northern zone of the Riff Range in 1904. In 1909, as a result of great diplomatic pressure, Germany recognized the special political rights of France in Morocco in return for a part of equatorial Africa. With the elimination of the three rival powers, France set about consolidating its position, and though the Sultan is nominally independent, France has complete administrative, economic and military control. The French have been good colonial administrators, and their efficiency is nowhere better seen than in Morocco. France has recently given close attention to the possibilities of connecting the Sudan and French West Africa with Morocco and Algeria on the north, by the construction of a Trans-Saharan railway to Daker. It considers this essential for the realization of the wealth of French West Africa.

8. GERMANY

Rapid rise. Commercially and industrially, Germany, with an area of 180,000 square miles and a population of over 66,000,000, is a very advanced country and its rise to power has been phenomenally rapid and striking, so that it has become a great competitor of England in the markets of the world. The strength and stability of the Government after the Franco-Prussian War when the Germanic lands were welded into a political union under the hegemony of Prussia, and the *zollverein* or the customs' union long before, paved the way for the development of Germany as a great European and world power. Many factors contributed to this rapid rise. It had a central position in Europe, with rich and advanced neighbours. Its rulers believed in education for the masses, and technical education received particular attention. Its population increased rapidly and provided abundant labour, skilled and intelligent. The indemnity received from France in 1871 provided capital utilized in the development of industries, which were favoured by the possession of important coal, iron and potassic salt deposits. Internal communications rapidly improved, efficient trade and consular services were established, and Germany attained a position of first importance.

Agriculture. Agriculture has been organized with great efficiency, whether on the large estates in the east or the smaller holdings of the peasant proprietor in other parts; scientific methods are employed, and the highly organized agricultural development with its experimental stations and demonstration farms and the efficient agricultural banks, the rural co-operative societies and the *landschaften* enable German agriculture to reach a high level in spite of its comparative climatic inferiority to France and the consequent production of less valuable crops. It is the leading producer of beet-sugar; vines grow well in the sheltered valleys of the south-west; rye and the potato are important crops; Saxon and Silesian wools are well known; extensive pastures on the northern plains and the bleak Bavarian plateau enable cattle-rearing and dairying to be carried on there as well as in the Rhineland and in Schleswig-Holstein. Forestry is an industry of great importance conducted on scientific lines under the care of the state.

Minerals. The great bulk of the minerals raised in Germany is produced in Prussia. The Ruhr valley coal-field is famous, and the Saar valley coal-field is also very important; lesser coal-fields are found in Saxony and Silesia. Lignite, or brown coal, is abundant and gives rise to a large mineral oil industry and furnishes fuel for the sugar refineries of Saxony and Thuringia. Lorraine was an important source for iron ores; but it has been lost to France as a result of the World War, and iron ores have now to be obtained from the area between

Cologne and Frankfurt and from the Harz mountains. Potassic salts are very important in the Prussian province of Saxony with Stassfurt as the most important centre of chemical industries and Schonebek with the largest salt works.

Industries. The chief seat of the German iron production is the Ruhr; steel is chiefly made there; and Essen, famous for the Krupp works, is the chief city concerned in this industry. The electrical industry is found principally in Berlin, while the chemical industry is centred on the Rhine, near Mannheim on the Main, and at Cologne, and in Prussian Saxony. Shipbuilding under state encouragement is a leading industry, with its chief centres at Stettin, Bremen and Bremerhaven, Hamburg and Cuxhaven, Kiel, Lubeck and Rostov, and, for river steamers, at river ports like Dresden. The textile industries are important too, woollen at Aachen and Barmen-Elberfeld, silk at Krefeld, cotton at Chemnitz.

Trade. The foreign trade declined considerably during the present great economic depression, the exports being 4,166 million marks and the imports being 4,451 million marks, manufactures predominating as exports, and food products and raw materials predominating as imports. Iron and steel, dyes, and chemical products are the leading exports, while raw cotton and wool, mineral oil and coffee are the leading imports. German trade with the Netherlands is of particular significance, as Rotterdam acts to a large extent as a collecting and distributing centre for Germany. Germany's trade is important with its neighbours, Italy, France, Belgium, Austria and Czechoslovakia, as well as with the United Kingdom and the United States.

Transport. The total length of German railways is a little more than 36,000 miles and inland waterways total a little over 7,000 miles. In war, Germany may be ringed about by enemies, but in peace she is ringed about by customers; and the provision of a close network of railways to guard its frontiers by facilitating the movements of armies and the efficiency of the military organization has been one of the precautions imposed by its situation. Air transport also has developed rapidly in Germany; indeed, no other country in the world has developed such highly organized air-transport lines. There is hardly any German city of consequence that does not have its airport with full meteorological and radio or telephone and telegraph equipment.

Colonial aims. By the end of the last century, German industries had made such progress that they came to be regarded as typical of the highest efficiency of modern organization. Its philosophers then propounded the theory that every nation had a natural right to larger areas commensurate with its increasing population, developing industries and expanding commerce, and this attitude was reflected not merely in German aspirations for colonial possessions overseas but also in a new angle of vision towards its European neighbours. The commercial service from Hamburg to India was initiated at this stage; the idea of the B.B.B.Zug (Berlin-Byzantium-Baghdad Railway) was pursued in furtherance of its designs in the East; attempts were made to bring Austria-Hungary and the Near East within the German political orbit; and the Turkish relations were so cultivated as to enable it, under suitable conditions, to reach the Indian Ocean and be a more effective sharer in the rich trade of India and the Far East. Before the War, three chief possibilities of economic expansion were envisaged by Germany. The first was German maritime supremacy, the second the economic domination of the Near East, based on the B.B.B., and the third was the establishment of economic ascendancy over Russia which could absorb vast quantities of the products of German industries and which could be a sure source of raw materials. At the end of the World War, seven states were created on the western border of Russia: Finland, Estonia, Latvia, Lithuania, White Russia, Poland and the Ukraine; and it was possible for Germany to push forward its policy of an eastward movement of German settlers and even more of the products of German industries to the Baltic states in order to obtain economic domination over Russia since the Soviet Government could maintain its control over eastern Siberia by concentration there and by giving up the Baltic provinces. Later, the estrangement of England and France with the Bolshevist led to the Soviet turning towards Germany. Quite recently, however, France has abandoned her suspicions and has entered into friendly relations with the Soviet Government, with the result that the German aims in the Baltic States and the Ukraine are being given clear expression, and relations between Germany and Russia are apt to be strained.

Losses in the World War. Germany's losses as a result of her defeat in the World War were immense. She was deprived of her colonies, her mercantile marine was greatly reduced, her naval strength was kept down to a protective level, and friendly commercial relations with Germany ceased. The loss of Alsace-Lorraine was not only a reduction of the size of the Empire, but also a loss of great iron and potash deposits; the Rhine ceased to be entirely a German river; in losing Schleswig, she lost part of a strategic frontier; the loss of Danzig meant giving up an important port on the Baltic; the loss of German Poland meant the loss of the prosperous industrial district of Posen.

Austria and Poland. A large number of Germans reside in non-German countries in Europe and this fact is responsible for a great many complications of European politics. Austria has a large German population and the union of these two countries would bring about a larger and more homogeneous Germany than existed before the War; it would bring Germany nearer to the Adriatic. Even though there have been losses in the east and west, there still remains a very compact Germany that stands unsurpassed in all Europe as regards organization, skill and efficiency, and a union with Austria would add immensely to its strength and revive the old German dreams and aspirations. Quite recently, the inevitable has happened, and taking advantage of the confusion into which Europe was thrown by the Italian conquest of Abyssinia, an Austro-German customs' union was announced, a forerunner of a political union to come at the earliest favourable opportunity.[1]

There are about 2,000,000 Germans in Poland and about 3,500,000 in Czechoslovakia. There is a similar problem in respect of the German-speaking Austrians in Italian Tyrol. In all these countries, the German population forms a minority group ever discontented and obstructive. The partition of East Prussia by the intrusion of the **Polish corridor** raises a problem of the first magnitude. Germany refuses to accept it as final, and in the event of a general European war, Germany would not hesitate to launch a determined attack to absorb the corridor and reunite East Prussia once more.

[1] This union has become an accomplished fact whilst this book has been in the press.

Colonial expansion in Africa. Germany started on the road to colonial expansion much later than Great Britain and France, who had for a century been acquiring rich experience in colonial administration. The richest areas were already colonized and the scope for further colonization in Africa and elsewhere was greatly restricted. When Germany realized the great value of securing, in colonies, an unfailing source of raw materials for its rapidly developing industries, it perceived the need for an active push, and sought to make up for its late start by a skilfully directed policy of vigour and aggression. More than fifty trading stations on the coasts of Africa were soon established, and many more missionary stations were developed. In 1884, Germany established itself in South-West Africa, a German protectorate was declared over Togoland, and the Cameroons were occupied. In 1885, Britain recognized the claims of German traders in East Africa; by 1890, a definitely demarcated portion of East Africa was acknowledged as a German colony; and this phase of German colonial expansion in Africa came to an end. Germany's cherished ambitions of a German African Empire, not only by developing its own African colonies, but also by acquiring adjacent colonies, were frustrated by its defeat in the World War, and Germany received a great set-back. Two of its colonies have now been assigned as mandates, one to Great Britain and the other to the Union of South Africa, while Togoland and the Cameroons are shared between England and France. Germany has not accepted the situation as final, and has announced its determination to strive for the restoration of its colonies.

In the Pacific. So far as the Pacific is concerned, there have been four stages in the history of German colonization. The first stage was actuated by purely commercial motives; the second led to annexation and to extension of the German Empire; in the third, the Pacific islands were viewed not as merely commercial or territorial gains, but also as naval bases from which the influence of the Empire would radiate to rich and prosperous lands. The fourth or the present stage marks the complete disappearance of Germany from the Pacific. The *condominium* of Great Britain, the United States and Germany that was set up at Samoa in 1880 ended in 1899 when it was divided between the three powers. Britain, however, was bought off by Germany with concessions in regard to Tonga and the Solomon Islands. Samoa is now a mandated territory under New Zealand. In 1884, Germany occupied the northern shore of New Guinea and the whole of the Bismarck Archipelago. German New Guinea or Kaiser Wilhelm's Land has now been assigned to Australia as mandatory power. In 1886, Germany annexed the Marshall Islands and in 1899 acquired by purchase from Spain, the Carolines, the Mariannes and the Pelew Islands. These island groups have now been placed under Japan as the mandatory power—with the exception of Nauru, which is a British mandate, worked for the benefit of New Zealand and Australia.

Importance of colonies. Germany has lost all her colonial possessions. Colonial possessions rarely pay their way and yet colonies are regarded as of great importance and value to the motherland: if not directly, at any rate indirectly. They add to the prestige of a sovereign; the people feel a sentimental interest in them; but sentiment counts after all, for territorial expansion is regarded as a symbol of progress. Even the renaming of acquired territory appeals to human vanity; the navy and the army, commerce and industry all get busy over problems of aggrandizement, advancement and aggression, and it is the leaders of these departments of national activity that demand colonial possessions, rather than necessity resulting from over-population or a high birth-rate. Germany's interests and pride are thus both involved in the problem of the restoration of colonies and the question assumes a very alarming aspect in European politics today.

The handicaps of present Germany are great, but the intelligence, resourcefulness and perseverance of her people will enable them to rise above them and emerge stronger than before. Germany has to restrain itself, for the close co-operation between England and France precludes any possibility of its success in a war against them. These two countries, however, co-operate not because of any community of aims, commercial or otherwise, but because both earnestly want the maintenance of security and peace, and Germany is a stronger military power than either of them. When differences between France and England become acute and irreconcilable, the opportunity of Germany will come, when she will push forward her schemes for the achievement of her aspirations—the return of her colonies, and the union of the Germanic people under one strong rule. The establishment of Nazism in Germany, of Fascism in Italy, and something allied to it in Spain, and the Franco-Soviet Pact are signs of the times which cannot be ignored; for they point to a coming conflict of aims and the imperative need for readjustments perhaps beyond the powers of diplomacy, either individual or collective, under the auspices of the League of Nations.

9. ITALY

Situation. Italy, the pier-head of Europe, is a lowland peninsula, shut off from the rest of Europe by mountain ranges, the highest in the Continent. The plains are open to the sea and intercommunication is not very difficult. The chain of the Apennines striking diagonally in Italy from north-west to south-east is connected with the Alpine system at Col dell Atlare near Savona. The country has an excellent situation for commerce as the central one of the Mediterranean peninsulas, and a fine coast-line, excellent harbours and large islands further improve that situation. Geographically, the Alps isolate Italy, but modern engineering skill has enabled direct communication to be maintained between it and France via the Mount Cenis tunnel, with Switzerland and Germany via the St. Gothard tunnel, and with south-western Switzerland via the Simplon tunnel. Italy is the natural mistress of the Mediterranean; but the course of history has conferred that position on the greatest naval power of the World, Great Britain; and the aspirations of the Italians are tending to convert a geographical indication into an actual fact.

Population. Italy has an area of about 120,000 square miles and a population of 41,200,000 giving the very high density of 344 persons to the square mile. At the beginning of the century, the population was about 32,500,000, so that during these thirty-six years it has grown by about 8,700,000, a very substantial increase indeed, creating the problem of an increasing population and its adjustment to territorial expansion. The number of Italians living in other countries is estimated at a little under 10,000,000. Elementary education is free and compulsory up to the age of fourteen.

Progress. The North Italian Plain, largely the plain of the Po, is a depression between the Alps and the Apennines, the lower end being the Adriatic Sea. It is a fine agricultural area where high-grade farming is carried on, and maize, rice and silk are extensively produced. Venice, the Queen of the Adriatic, built on many small islands, separated by canals and connected by bridges, with sand-banks and lagoons in front and marshy lagoons in the rear, is one of the chief towns of the plain; Milan, the most progressive of Italian cities with its fine cathedrals and art galleries, and its silk industry, and Turin in Piedmont, with routes diverging to the Lower Rhone valley, to central France and to Geneva, are others. Wheat is the principal crop, Apulia in the south-east is well known for macaroni, and wines, and olives are also of consequence. Sulphur ore is the most important of the minerals and is found chiefly in Sicily, while the textile industry is the most important of the industries which have developed in recent years with remarkable rapidity, with cheap labour and water-power. Sericulture is carried on all over the plain, but is most extensive in Lombardy, Piedmont and Venetia; the production of artificial silk or **rayon** has also become a very important industry. Artistic and semi-artistic industries are characteristic of Italy; such are the glass-works and lace-making of Venice, the mosaic work and fine earthenware-making of Florence, the coral and shell work of Naples and Florence, the straw-plaiting of Tuscany and sculpture in marble and alabaster and artistic woodwork generally.

When Great Britain and France were entrenching themselves in new colonial areas in America, Africa and the Far East, Italy was a bundle of states in the Mediterranean sphere, and when at last Italy after its unification decided to become a colonial power, it found that rich lands were all occupied and that what remained was but poor land without any great possibilities. Libya is hardly important as an area of colonization and the East African possessions of Italy can hardly be regarded as valuable. The Mediterranean shores are poor in coal, and Italy has therefore to import it from England, or, as recently, from Germany. Without coal or petroleum, Italy finds it very difficult to achieve industrial progress. Italy therefore concentrates on developing its huge resources of hydro-electric power in the north. Its merchant fleet has been increased in tonnage and numbers so as to reduce the freight charges otherwise payable by Italy to others. The pressure of a growing population is great and how to feed its people constitutes a great national problem. Food-stuffs have to be imported from the other Mediterranean lands and from America. The balance of trade is unfavourable and the only solutions are expansion overseas, or lowering of the standard of life. It is noticeable, however, that in spite of this pressure of population, Italians prefer emigration to prosperous countries demanding cheap labour to settling on the new territorial gains of Italy.

Italy and the Adriatic. The World War gave to Italy all the territories south of the Brenner Pass, thus redeeming **Italia Irridenta** from the Austrian menace, and furnishing an outlet for Italy's population; and the active Italianization of the region was taken up in real earnest. The Adriatic is looked upon by Italy as an Italian lake. Italy therefore struggled for an advance on the Dalmatian coast, and secured the port of Fiume from Yugoslavia, in addition to the peninsula of Istria and a few islands, which she received as the spoils of war. Great Britain, France and Yugoslavia (more particularly the two latter) being hostile to its advance along this coast, Italy turned to Albania and succeeded in establishing a virtual protectorate over that little state in 1926-7, while France made a mutual defensive alliance with Yugoslavia. Italy feels aggrieved by her exclusion from major gains when she had joined the Allies in the World War only on the definite promise of protectorates over Central Albania and Southern Anatolia, in addition to large territorial gains in Africa.

In Africa. In Libya, Italy gained some small areas by agreement with France and Britain. But neither Libya nor Eritrea and Italian Somaliland offer any scope for immigration and settlement. Italian trade with these colonies is small and the prospects of an increase was doubtful previously to the conquest of Abyssinia. Italy has tried therefore to secure a position of dominance in Yemen, in the south-western corner of Arabia. Italian credits and material supplies to Yemen have given to Italy an advantage which she might utilize when opportunity occurs in negotiating with Great Britain or France.

Fascism. Since 1922, Italy has gone through a striking political and social revolution. Fascism, like Communism in Russia, and Nazism in Germany, is a bold experiment. It has two aspects: one is concerned with internal affairs under the new system of government, and the other with foreign affairs. A system of government by corporations has been evolved, which insists on compulsory co-operation between capital and labour under the supervision of the state. A system of compulsory arbitration has put a stop to labour troubles and has ruled out strikes and lock-outs. There are thirteen confederations, six for employers and six for the workers in Agriculture, Industry, Commerce, Banks and Transport, Maritime and Naval Transport, the thirteenth being for Arts or Liberal Professions.

In the realm of foreign policy, the Fascist state is an assertive and aggressive centralized Government, dissatisfied with the advantages Italy gained as a result of the World War. Foiled in every direction, Italy picked a quarrel with Abyssinia and conquered it early in 1936.

Abyssinia. Abyssinia (or Ethiopia) with an area of about 400,000 square miles is an isolated country, surrounded by deserts, semi-deserts and great swamps. The climate of the country is temperate because of high altitude, the labour supply is adequate and the resources are great, so that several European powers, Great Britain, France and Italy were attracted. Economic penetration and exploitation began. Italy saw in Abyssinia the means to connect its African possessions, Eritrea and Italian Somaliland. French Somaliland is small and France felt, for its proper development, the need for a wide hinterland, and the Jibuti-Addis Ababa railway lent weight to French claims; while Great Britain has sought and received recognition of her special interests in Egypt, in the Nile basin and their Ethiopian connexions.

The Italo-Abyssinian War was a short one, the well-equipped Italian armies having not much to fear from the Abyssinians, who, though brave to the extent of heroism, could not cope with the invaders for lack of ammunition and modern warlike materials. The civilized world remained neutral, though British and French interests prevailed upon the League of Nations to consider Italy as the aggressor and tried to enforce sanctions against her. But while the tardy machinery of the League was in motion, Italy completed its conquest and presented to the League a fact accomplished. Italy has by this conquest satisfied its pride and its tradition of a Roman Empire and has also obtained a population of about 10,000,000, and raw materials of which potash deposits and undeveloped coal and oil resources are the most important.

10. JAPAN

The Japanese Empire consists of five principal islands —Honshu (main island), Kyushu, Shikoku, Hokkaido (Yezo), and Taiwan (Formosa), the peninsula of (Korea) Chosen, the southern half of the island of Karafuto (Sakhalin), and several small island groups such as the Riukiu (Luchu) Islands and the Chishima (Kurile) Islands. The total area is 260,000 square miles and the population is a little over 90,000,000. The number of Japanese residing abroad is about 675,000 of whom about two-thirds are in America, and the rest largely in China and the other lands on the eastern coast of Asia. Elementary education is compulsory and the whole population is generally literate.

Great Britain of the East. Japan is thus an island empire with countless isles, and extremely well situated for commerce, being opposite to countries highly industrious and commercial; and it has often been spoken of as the Great Britain of the East. The coast-lines in both are indented and have good harbours; a warm ocean current washes the shores, the Kuro Siwo in Japan and the Gulf Stream in Great Britain; the climate, foggy in both cases, is less extreme for the latitude than in the mainland countries; the people are industrious and commercial, and are conservative, though thorough-going in revolutions; the capitals of both are very large cities, aggregates of towns and villages, London being a wilderness of bricks and mortar, Tokyo, of bamboo and paper, both command large oceans, the one the Atlantic, the other the Pacific; both have important fisheries in the adjoining land-locked seas, the one in the Dogger Bank in the North Sea, the other in the Sea of Japan. There are differences between the two. Great Britain is more of a lowland, Japan more of a highland region; Britain is more connected with, and is more open to the continent because of navigable rivers and fertile lands, while Japan rises steeply from the sea in forested mountains; Britain is more compact and homogeneous, Japan has a more varied flora; Britain has much better waterways and a milder climate; Japan is poor in coal but rich in water-power; the crust of the earth is very unstable in Japan, which experiences frequent earthquake shocks of great intensity. Great Britain is on the western while Japan is on the eastern margin of Eurasia; Great Britain is in the region of the westerlies, while Japan is in the temperate monsoon region. The British people are of white stock, the Caucasians; the Japanese are yellow people, the Mongolians.

Rapid rise. The emergence of Japan as a world power is comparatively recent, and the rise has been striking and spectacularly rapid. The Japanese have shown great adaptability in imbibing good from every nation, and have completely changed their old time spirit of isolation, feudalism and suspicion of foreigners into one of imitation, assimilation and determined aggressiveness. The change in the attitude of the Government towards western nations was reflected in the great eagerness displayed by it to learn, by teaching western languages in schools and colleges, by bringing into Japan foreign experts in various sciences and by sending out scholars to Europe and America. The change in the attitude towards trade was seen in the encouragement given to foreign trade, in the study towards that end of foreign markets by trade missions and by an efficient consular service, by throwing open the whole country in 1899 for foreign trade, by subsidizing, nursing and protecting industries, and by a rapid modernization and mechanization of industries and transport.

The isolated glens and valleys and plains favoured a strong clan feeling under feudal barons and the mikado lived in a semi-divine seclusion at Kyoto, while the military and administrative power was concentrated at Tokyo in the hands of the most important of the feudal barons, the shogun. The Japanese revolution of 1868 destroyed the shogunate, the mikado came out of his seclusion to Tokyo to resume power, and a constitutional monarchy was established. Japan has been very profoundly affected by the impact of western civilization and its political and social organization experienced the most thorough-going revolution. The feudal spirit was replaced by a national spirit which is a great asset in empire-building.

The three wars. The emergence of Japan as a great world power was marked by three wars. The first was the Sino-Japanese War of 1894-5 ; the second was the Russo-Japanese War of 1904-5 ; and the third was the World War. The Sino-Japanese War revealed the strength of the new Japan and the weakness of China. Formosa and Korea were obtained as prizes of the war ; but Russia, in co-operation with France and Germany, drove out Japan from the mainland in the Liao Tung Peninsula and Port Arthur. Germany forced from China a lease for ninety-nine years, of Kiao Chow in the Shantung peninsula, Russia secured a twenty-five years' lease of Port Arthur ; Britain received additions to the area under its control at Wei Hai Wei and obtained from China recognition of its sovereignty over Sikkim. France gained influence over an area at Kwang Chowan. The Russo-Japanese War transferred to Japan Russia's right in Port Arthur and the Liao Tung Peninsula and led to the Russian evacuation of southern Manchuria and southern Sakhalin. The Anglo-Japanese alliance of 1902 and 1905 supported Japan in its eastern Asian policy. The penetration of China by other nations did not alarm the United States. But the demands of Japan were so thorough-going, its attitude was so militant, its geographical situation was so favourable and the racial affinities between China and Japan were so great that the United States took up the matter. It stood forth as the champion of distressed China and pressed for equality of commercial opportunity, seeing a possible chance for American capital and industry. The World War gave to Japan the Marshall and Caroline Islands in the south Pacific. These are being fortified and are valuable Japanese bases in case of any conflict with the United States or any other Pacific power.

Manchukuo. The increase of population is a problem of great importance to Japan. Manchuria and Mongolia are vast areas in a primitive stage of development and yet have resources great enough for the support of a large population. Wool and meat, soya beans, and resources in oil, coal and iron are necessary to Japan's industrial development. Moreover, the position of Manchuria is, from the Japanese point of view, strategically important. Japan has therefore adopted a very determined attitude towards Manchuria, from which even the great pressure of the European powers, particularly Soviet Russia, has been unable to dislodge it. In 1932, Manchuria with Jehol was constituted into the independent state of Manchukuo with the capital at Changchun, renamed Hsinking. The ex-Emperor of China has been made Emperor of Manchukuo, which is virtually a protectorate of Japan.

China. Japan, in recent years, has pursued a policy of determined aggression in China, where it holds a position of very great importance. Commercial penetration has been proceeding all these years at an increasing rate and Japanese investments have already assumed large proportions. The disorders in China are being fully fomented and exploited by Japan, as they assist its purpose of separating the four provinces of northern China and inner Mongolia as autonomous states, obviously under Japanese influence. Great Britain has vast commercial interests at stake also and so has the United States. How these countries will adjust their competing interests with Japan, which is absorbing a disintegrating China, is a vital problem of the near future, in which Great Britain is handicapped by its preoccupations in Europe and India, and the United States by its immense distance.

The United States. One of the most significant deficiencies in the resources of Japan is the lack of oil. It has to depend very largely upon the United States, though it gets some supply from the East Indies. This dependence on foreign sources will continue till the Sakhalin and Manchukuo resources become a reality. Silk exports, so important in Japanese foreign trade, are largely to the United States, which is also one of the principal sources for the import of raw cotton; the deficiencies of Japan in wool are made up by imports from Australia, while rubber and sugar are obtained from Java and the other islands of the East Indies. Japan cannot therefore contemplate with equanimity a war with the United States; for that would mean disaster, and the collapse of a large and valuable part of its foreign trade and the disorder and wreck of its economic life. But with Chinese resources and markets under Japanese control, Japan could throw off its foreign dependence and stand out as one of the greatest powers in the world.

Japanese trade has grown very rapidly since the Great War. Japanese traders have established themselves strongly throughout the East; they are active in Bombay and Calcutta, Singapore and Bangkok, Hong-kong and Manila and Shanghai and Tientsin. Japanese banks and warehouses in India are assisting great developments in the Indo-Japanese trade; Japan's trade with Siam has grown quickly and Japanese influences in that country are sources of anxiety to European powers. Trade with the Dutch East Indies has increased wonderfully and Japan is assuming an important position in the trade of New Zealand. Japan, during recent years, has exported large values of textiles to India, whilst India has, at the same time, immensely increased her own output. The combined result has been a great loss to the cotton manufacturing industry of Great Britain through a decrease in the Indian piece-goods imports. Japan is competing for markets farther westwards also, in Egypt and in Italy, and the German ex-Kaiser's **yellow peril** is now being realized more and more as Japan, the land of the Rising Sun, stands forth as a great industrial and manufacturing nation of the east and the dominant power of the Pacific, ready to assert and enforce an Asiatic Monroe Doctrine, as time and opportunities permit.

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