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THE GEOGRAPHY OF PLANTS

BY

M. E. HARDY, D.Sc.

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PREFACE

In the preface to Dr. Marcel Hardy's *Introduction to Plant Geography*, Professor Herbertson wrote, 'it will be followed by a more advanced book'. This 'more advanced book' is the volume now published.

Many causes have contributed to delay its appearance: the death of Professor Herbertson; the departure of the author to South America; the War and its aftermath, which have rendered so extremely difficult everything connected with the publication of books: but the proofs have been fully revised, and many new photographs have been inserted.

It may be taken as in some sort an expansion of Part III of the earlier work, since the slight 'survey of the continents' given there has served as the plan for the new book, and has been expanded into a full discussion of the conditions in which plants flourish, and their distribution in the great geographical divisions of the earth. An index of the plants mentioned is appended, with the scientific or popular name, as the case may be: where the author has used a precise name, the exact equivalent is given; where a genus only is indicated, the corresponding generic term is set down, unless some particular species is peculiarly characteristic

of the region described, when the full name of that species is added.

Thanks are most gratefully offered to the Belgian Government, Professor A. W. W. Brown, Col. Coachman, Mrs. Cross, Miss Czaplicka, Mrs. Doyne, Sir S. Eardley Wilmot, Mrs. Edwards, Captain C. T. Ffoulkes, Sir H. H. Johnston, M. J. Lagarde, Mr. W. Lloyd, Mr. H. M. Loucas, Mr. C. W. Mathers, Messrs. Seeley, Service & Co., the Controller of H.M. Ordnance Survey, Professor A. Donaldson Smith, Sir Aurel Stein, Mr. M. S. Thompson, Sir Everard Im Thurn, Mrs. Traill, Messrs. Underwood and Underwood, the Visual Instruction Committee, Mrs. Watkins, Mr. C. M. Woodward for the loan of photographs from which the illustrations have been made, and to Miss MacMunn for most kindly reading through the final proof.

Miss Kirkaldy very kindly made herself responsible for seeing the book through the press.

OXFORD, 1920.

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CHAPTER I

ASIA

THE stupendous size and compact shape of this greatest of continents are features which by themselves are bound to exercise the strongest control on its vegetation by determining the climate. The centre of this vast body of land is so far removed from the regulating influences of large sheets of water that it must, of necessity, be dry, extreme in climate, and barren; and life, whether vegetable, animal, or human, must be reduced to a minimum. Asia is a land of extremes. Broadly speaking, life is distributed, starting from a dead centre, in concentric belts of increasing density. In this very general arrangement, however, the fact of its excentric symmetry with regard to the Equator introduces a first and fundamental irregularity.

The northern shores penetrate far into the polar circle, while the southern coast is bathed by tropical seas. All other things being equal, such a difference in the amount of atmospheric heat is bound to be expressed by a difference in the amount and the character of life on the two sides. The exaggeration of summer heat and winter cold of the atmosphere over the far inland parts initiates corresponding movements of attraction and repulsion of the surrounding masses of air, or, in other words, large cyclones and anticyclones which have been termed *monsoons*: the rhythmic alternation of these forms the pulse of that vast body. As may be expected, the inflowing summer winds are, on the whole, moist

and beneficial, while the outflowing winter winds are dry and harmful.

Again, according to their origin, the inflowing winds produce unequal effects. Those called in from the warm Indian and Pacific Oceans are naturally laden with moisture which, on cooling, is condensed over the southern and eastern margins of the continent, thus inducing vigorous plant life. The air from the north and east, on the other hand, easily saturated at low temperatures, becomes gradually warmer and drier as it rushes inland, yielding but scant moisture to the low-lying plains and plateaus. A hardy but not luxuriant type of vegetation is the expression of such climatic conditions.

Another inequality arises from the situation of the neighbouring continents of Europe and Africa, which screen off any moisture from the western quarters, while the more favoured east lies open to the beneficial influences of the oceans. Thus the arid centre extends westward up to the uncertain borders of the adjacent land masses.

These broad features of the distribution of life on the surface of Asia, by the accident of shape, size, and position, are further emphasized by the nature of the relief. The central portions are raised thousands of feet above sea-level in vast plateaus which are fringed by an unbroken rim of still loftier mountain ranges. On that account, the excessive heating of the interior exaggerates the landward influx of air in summer while the intense cooling in winter adds impetus to the outward flowing winds. The limits of the barren interior are drawn more sharply by the screen of high mountains surrounding them. At the same time, the lofty ranges, such as those which cross the continent

from the Caspian to the Sea of Okhotsk, drain the winds of their last traces of moisture.

This moisture, deposited as spring rain or, in large proportion, as winter snow, causes a fairly continuous line of highland oases, the more marvellous in contrast

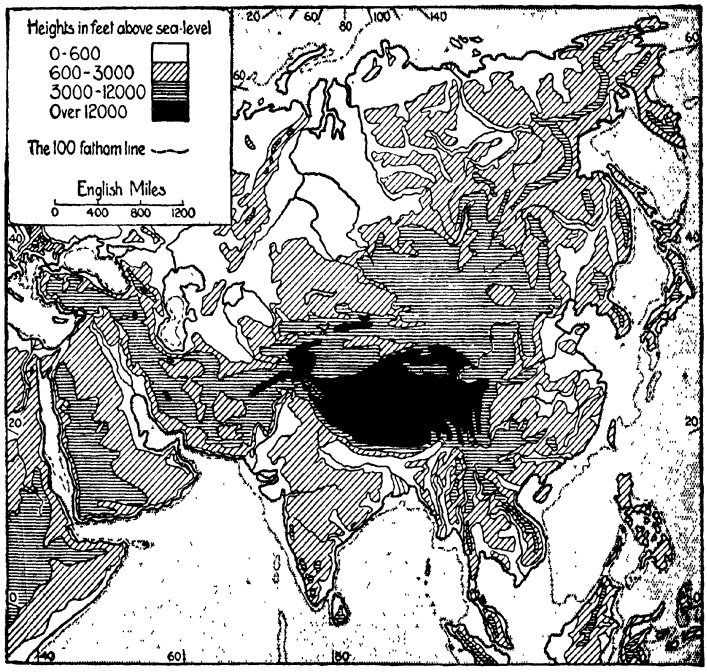


FIG. 1. Physical Features of Asia.

with the surrounding lowland deserts. At the same time, the snow-fed streams, before losing themselves among the sands of the plains, fertilize a stretch of country at the foot of the mountains; and of this alluvial belt, even before the dawn of history, advantage was taken by man. The influence of these lofty Asiatic

chains is thus seen to be double, as being expressed in abundant summer pastures on the upper slopes, and in gardens and winter pastures on the lower slopes and the adjacent belt. Correspondingly there originates a double influence on man and animals in quest of food: first, a yearly migration of populations between the lowlands

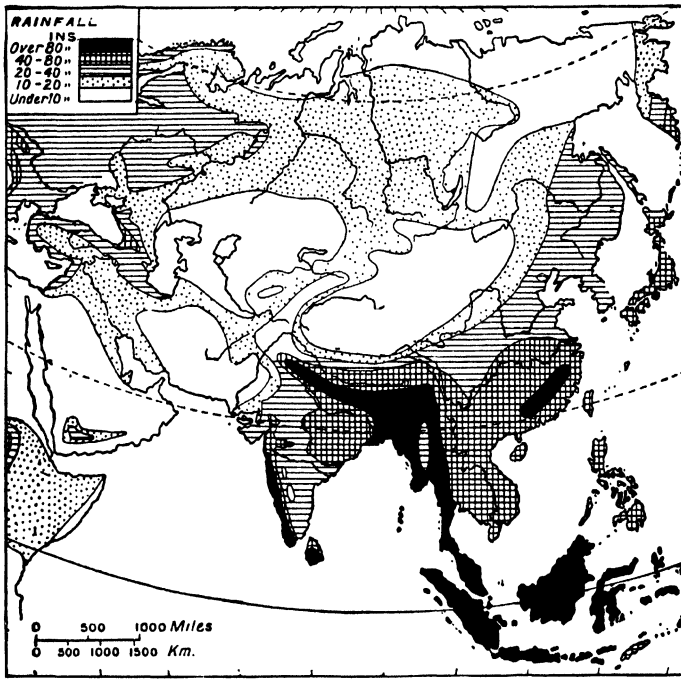


Fig. 2. Mean Annual Rainfall of Asia.

and the highlands, between the drought and the snow: second, larger movements of nations along the fertile piedmont belts, which naturally became the highways of history, as peoples were forced by various causes to migrate, and trekked between the deserts on one hand and the mountain wildernesses on the other.

In brief, then, the distribution of plant life in Asia, which, at a first glance, appears to be in widening belts of increasing density, has to be further analysed, the north being poorer than the south and the west than the east. The south-eastern quarter is the centre of radiation of plant life for the whole continent. Of the

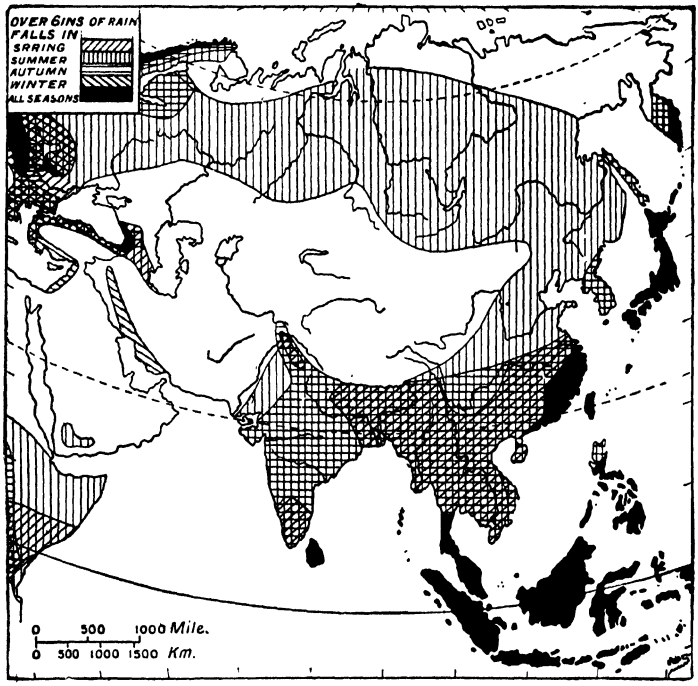


FIG. 3. Seasonal Distribution of Rainfall in Asia.

two western quarters, the northern, having more water and less heat than the southern, is also more luxuriant.

Tundra. Along the Arctic Ocean, Asia possesses an enormous development of coast-line involving about one-third of the parallel of 70° N. This coast-line lies, on the whole, much nearer the pole than the corresponding

shores of the mainland of North America: one would therefore expect to see a correspondingly greater extension inland of the cold treeless desert called the tundra. As a fact, however, it is not so; the barren grounds of North America reach much farther south, especially towards the extreme east and west, and when

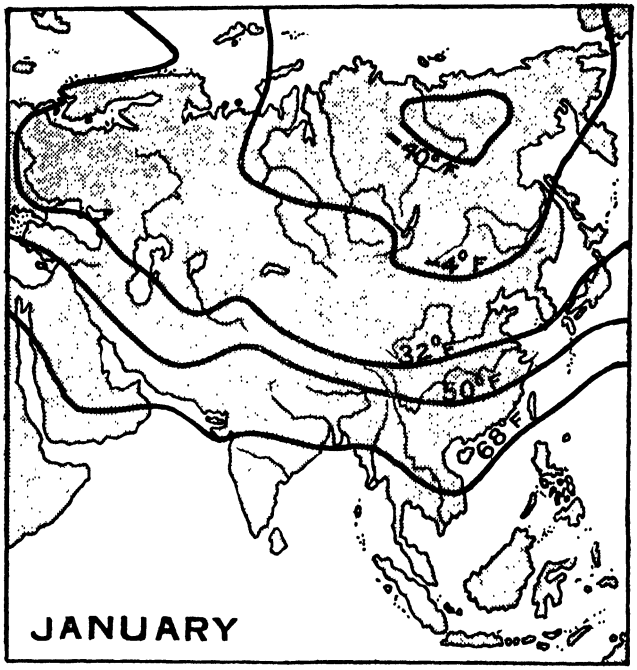


FIG. 4. Mean Temperature of Asia in January reduced to Sea-level.

the coast-line advances poleward or retreats southward, the accompanying belt of tundra follows the same oscillations. This broad fringe covers a low-lying undulated land, interrupted by no high hills, but indented by wide estuaries and marshy deltas.

Two main forms of tundra are recognized, the moss

tundra and the lichen tundra. The moss tundra is the moister kind, and is formed of peat-hills and puddles. The peat-hills are enormous spongy cushions, built up by the slow accumulations of gradually decomposing mosses: they are frozen inside, and have a velvety covering of

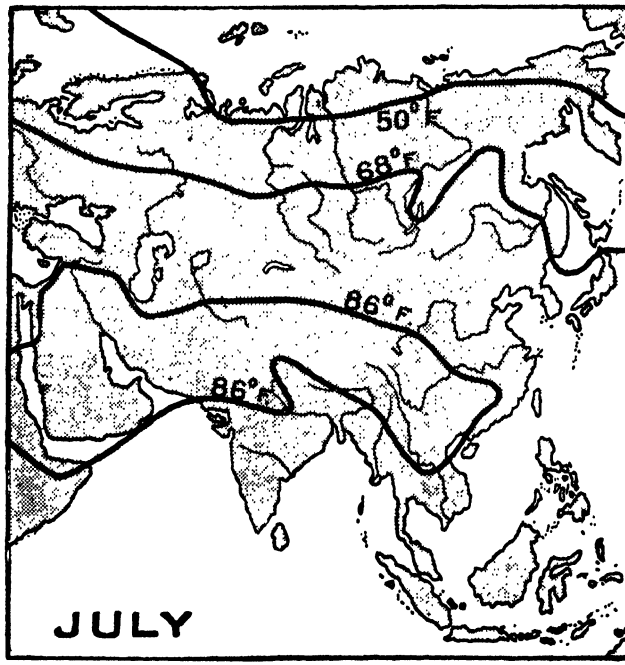


Fig. 5. Mean Temperature in July reduced to Sea-level.

straight-stemmed mosses, among which a few dwarf flowering plants are sometimes scattered, and in between the mounds wind the marshy tracts or puddles, often grown over with peat-moss.

The lichen tundra has a drier soil, but requires an abundance of rainfall, drizzles, mists, and atmospheric

moisture, and, when it is overgrown with low shrubs, may become a heath.

Among the most curious features of these arctic landscapes rank the 'polygonal floors,' or floors of hardened

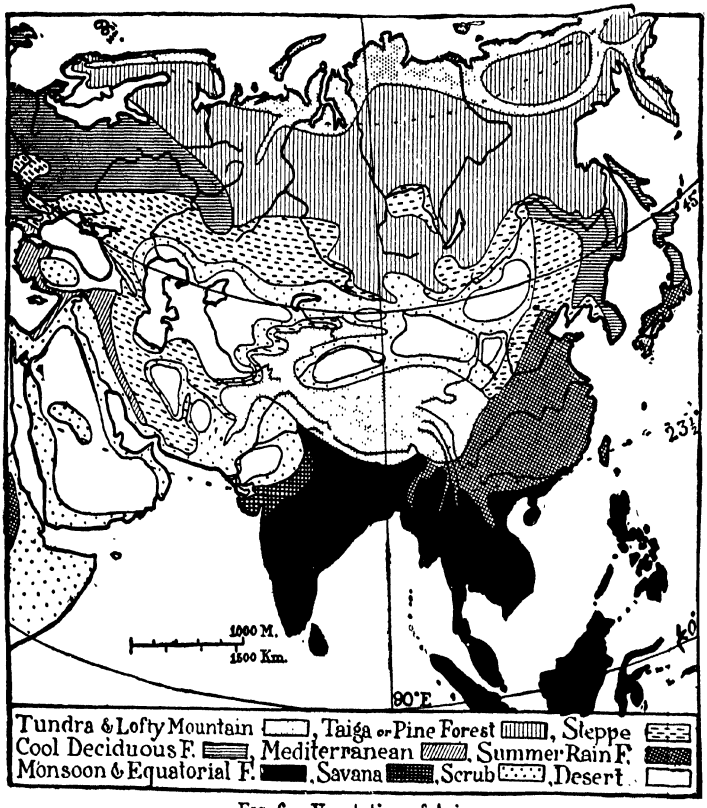


FIG. 6. Vegetation of Asia.

mud with cracks arranged in polygonal patterns. Out of these slits the lines of tiny plants arise in quaint devices not unlike fancy box edging.

The monotony and desolation of the landscape are

broken now and then by veritable gardens of gorgeous flowers which colonize the warm and well-drained slopes exposed squarely to the rays of the low sun of summer. The unusual brilliancy of colour in the blossoms as well as the leaves and stems of the small herbs in arctic and alpine regions is associated with the presence in the plant-body of certain substances protective against exposure.

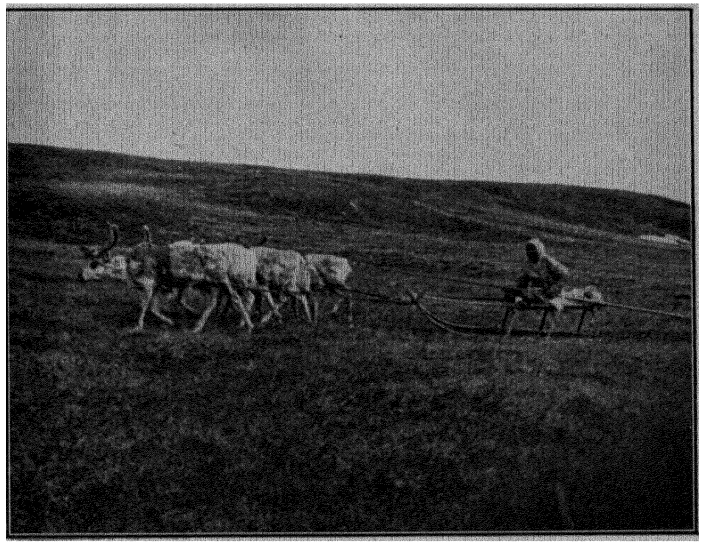


FIG. 7. Siberian Tundra.

The development of peat in the marshes of the Siberian tundra, being dependent on the moisture of the air and the length of the growing season, is not so important as might be thought at first. Heather or ling plays but an inconspicuous part, and our common peat-moss is of restricted occurrence.

There is little resource for the human being in such

regions. A few berries are all that man can gather, and cultivation is out of the question. Hunting and fishing are the primary occupations, but a most useful asset is found in the reindeer, whose every part and product becomes precious, while it supports itself on what lichens and mosses the tundra can supply. Man, therefore, is obliged to follow his wild herds, which he could not feed in a permanent and circumscribed place of abode.

The tundra extends to the higher lands or plateaus which stretch southward, such as those of Siverma, Yangkan, Verkhoyansk, Kolyma, and Anadyr, which recall the fjelds of Scandinavia.

West Siberia. Between the Urals and the Yenissei, north of the fifty-fifth parallel, the land is very low and flat, rising less than 100 feet in about 600 miles. It is regularly flooded by the large rivers Ob and Irtish and their tributaries, which have built high banks along their courses and thus stopped the natural drainage of the surface waters, so that it is covered by vast and impassable swamps, which remain frozen for six months of the year.

The climate is uniformly cold and damp, though the rainfall remains under twenty inches; mists and fogs are frequent, and snow lies on the ground till late in spring. Such a region is naturally the battle-ground between the swamp vegetation and the forest.

The tundra which surrounds the vast estuaries of the Ob and Tas gradually passes into morasses of a more temperate type, not unlike those of Ireland and Scotland, and consisting of peat-mosses. These freely alternate with swamps of reeds, rushes, and sedges, especially towards the south. The forest is restricted to the best-drained rising grounds—generally gentle swellings, and the banks

thrown up by the rivers—and is thus constantly intersected by innumerable marshy pastures, reedy moors, and peat-bogs. The vegetation is a mosaic of forests, meadows, and swamps.

These conditions of climate and soil are only suitable for conifers and a few hardy representatives of the broad-leaved trees, such as aspens and birches, willows, and alders. Siberian larches and spruces are the main constituents of these forests, the latter predominating on wet soils, and making dark, dense forests with little undergrowth. The lighter kinds of forest afford a shelter for northern types of plants, such as *andromeda*, several species of small rhododendrons, &c., a few herbs chiefly of the marsh-dwelling types, mosses, and ferns.

This vast extent of wooded marshes offers serious obstacles to travelling, and can best be crossed in winter, when it is all frozen and under snow. The dampness of the climate makes it unpleasant, more especially on account of the swarms of mosquitoes, which are an unmixed nuisance. The freezing of the waterways and seas to the north renders the marketing of the timber costly and difficult. It is only, therefore, during winter that a few tribes of Ostiaks frequent this locality to find in it a shelter against the terrible icy gales which sweep across the tundra, and to trap the fur-bearing animals when their coat is at its best. The timber as yet remains untouched, except on the southern margin.

The human population, therefore, remains confined to a few settlements along the main rivers, living largely on fish, getting the timber from the forests on the banks and resorting to a local kind of agriculture, which is, however, necessarily hampered by late frosts and icy mists. The backwoods and swamps are hardly ever visited by man.

Towards the west, the foot-hills and terraces along the Urals rise comparatively quickly, and the vegetation at once assumes a more varied aspect, including pines and firs, larches and spruces, luxuriant meadows and other hill-pastures.

Eastern Siberia. The country between the Ob–Yenissei divide and the Lena is fairly uniform. It is a low plateau, above which tower tabular volcanic heights. East of the Lena, however, the plateau rises gradually amid a somewhat broken landscape towards the crescent-shaped edge of the Stanovoi.

Compared with western Siberia, the eastern region is well drained, and possesses a drier and more extreme climate: indeed, the coldest winters and the hottest summers known on earth are to be found there, the range between the averages of the two seasons being 120° F.

The tundra, which covers the broad margin of the Arctic Ocean, sends spurs further south, along the most important ridges, similar to the fjelds of Scandinavia; but the formation of swamps and peat-bogs is limited here by reason of the extreme climate, the scanty rainfall, and the good drainage, and thus the vegetation is essentially one of forests of conifers.

Beech and oak could not live here, so the different species of conifers share the ground among themselves. The Scots and the arolla pine prefer the dry, sunny slopes and the lighter soils. The larch forms, on the cooler slopes and in the hollows, a light cover, which favours the development of a dense, often impenetrable, undergrowth of shrubs and herbs. The spruce occurs mainly in moist situations, where it forms a dark, heavy canopy, under which the ground remains almost plantless, covered with a thick mat of needles and mosses.

Siberian firs and stone (arolla) pines are also found in the east.

The lower vegetation differs very little from that of northern and central Europe, indeed, a large proportion of the species of bushes and herbs are common to Europe and Siberia. One would find bramble and wild rose, whortle- and other berry bushes, even aconites, monkshoods, geraniums, and stately *umbelliferae* in the pastures and meadows, but the ling is absent.

Despite the prevalence of forests, however, tree-growth is not luxuriant. Siberian forests are stunted, and the trees, hung and padded with mosses and lichens, reach no great height or thickness, but bear the imprint of the inimical conditions of the climate. They are also confined to relatively low altitudes. Thus, on the Lena, by 64° N. they stop below 700 feet. North of that latitude, the forest growth becomes increasingly scattered and dwarfed, pastures and meadows, moors, and stretches of tundra filling the intervening spaces. This is a condition similar to that in the backwoods of the northern Canadian forest, to which this east Siberian taïga corresponds exactly.

Thanks to the hot summer, coupled with a moderate rainfall, northern agriculture is possible in eastern Siberia. Dairy-farming and stock-breeding find there an excellent field; and grain crops are capable of a great development.

Amuria—Korea—Sakhalin—Hokkaido(Yezo). This is on the whole, a mountainous region lying to the north of the Ilchuri-Alin and the Little Khingan, and including the basin of the Ussuri and the upper basin of the Sungari. It consists mainly of a series of ranges and valleys parallel with the coast-line, and contains the broad valleys of the lower and middle Amur.

The climate may be described as cool temperate, although winters are very hard and protracted. The rivers, especially in the northern part, are ice-bound for four or five months in the year; but the region, on the whole, enjoys the benefit of the summer monsoon, which gives it a fair rain-supply. The conditions are temperate enough to permit of the occurrence of broad-leaved, deciduous forests of a central and north-European type. This is essentially a timber country, and the lower forest-belt is similar to our oak and beech zones. It consists of mixed forests, including the Mongolian oak, Manchurian kinds of walnut, hazel-nut, barberry, and vine, pines, maples, elms, lime-trees, and rowans: the Manchurian shrub dimorphanthus is freely grown in our gardens. This broad-leaved vegetation is, however, restricted to valleys, lower slopes, and foot-hills. In the mountains, the resinous forests naturally predominate, but they are also of a mixed type, including larches, cedars, pines, and tsugas, with birches and aspens, and giving the usual aspect of northern temperate mountains. In the broad valleys, the Amur and its tributaries flow amid luxuriant pastures of rich grass and tall herbs, among which umbellifers are most remarkable.

In spite of its hard winters, Amuria is a fertile land, replete with possibilities. Cattle-breeding, dairying, and mixed farming certainly find there as promising a field as in eastern Canada, with which this region has much in common: all northern cereals and green crops accommodate themselves to this climate. In Amuria proper the timber is well preserved, but in lower Manchuria, the western slopes of the Sungari hills and mountains have been largely deforested by the Chinese settlers, with the usual disastrous consequences.

Though in latitude it corresponds to central Europe,

Sakhalin has the same extreme climate with severe and prolonged winters, a fact due to the cold sea-current which bathes its shores, and to the continental north-west winds. The island is thrown into a succession of longitudinal valleys and ridges, and is entirely wooded, except for the floor of the valleys and the naked ridges. Here again, owing to the cold, damp, foggy atmosphere and bad natural drainage, the floor of the valleys is swampy, and peaty bogs of great depth recall the high moors of Ireland and Scotland, indeed, the bleak coast-belt seems to be an outlier of the subarctic tundra.

The Pacific slopes show the influence of the cold sea-currents and winds in their mixed coniferous forests of larches, pines, and spruces. Numbers of dead trees are left standing, and the litter of dead branches, together with the dense tangle of brambles, roses, and shrubs, make these forests almost impenetrable.

As a contrast, at a moderate elevation, the interior slopes, especially on the south-west, shelter a temperate vegetation of a mild character with broad-leaved forests, including walnuts, elms, maples, vines, yews, and even bambus six feet high, with fine hydrangeas and shrubby bilberries, recalling the vegetation of Japan. Similarly a verdant park-landscape, recalling that of Amuria even in its bogs, lies along the margins of the rivers of the inland valleys. Sakhalin proves thus to be a land of contrasts in its vegetation as well as in its climate.

It may remain chiefly a timber country, but it is possible that a good drainage may remove the blanket of peat from the valleys, and open them at least to grazing and dairying industries.

Yezo, the northern island of Japan, shares in some measure the conditions of south Sakhalin and the adjacent mainland, and is also densely wooded.

Okhotsk Region. Beyond the edge of the east Siberian plateaus, which extend almost to the eastern coast-line, the land sinks rapidly down to a narrow coastal shelf, and is carved into a series of parallel ridges, between which run short torrential streams.

This region naturally lies under the moderating influence of the neighbouring seas, and the moist and mild winds thereof; so that the rainfall is higher here than inland. At the same time, it is sheltered from the cold blasts from the interior by the edge of the Stanovoi. There is, in some measure, an approximation to the climate of southern Alaska, and the vegetation includes some of the types of plants of the American continent.

From the ice-fields and lichen moors of the edge of the plateau one descends into a belt of elfin woods, formed by a dwarf variety of our European stone-pine. Lower down, the slopes are clad with prosperous and dense forests of mixed conifers, among which American species are to be found; besides the dahurica larch there occur two kinds of spruces and one of tsuga fir; but conditions are still too hard for broad-leaved trees. Only birches and alders, poplars and willows, are to be found along the river courses; in the undergrowth the Kamchatka rhododendron forms dense bushes.

The lower valleys and the coastal shelf, lying most of the time under the belts of cold air and mists which settle down from the neighbouring heights, expand into dreary, quasi-arctic swamps, in the middle of which, along the rivers, run ribbons of rich green pastures.

Kamchatka. More desolate still is Kamchatka, which occupies, at the eastern extremity of Eurasia, a position corresponding to that of the British Isles, on the west between the 50th and 60th north parallels.

Kamchatka, however, is swept by icy winds from every part of the north—especially by the north-east gales. Its coast is bathed by the cold sea-currents from Bering Straits, and these give it a climate corresponding to that of Lapland, which it resembles in its vegetation. Parallel longitudinal ridges, from which arise very short torrents, form the core of the peninsula.

The characteristic vegetation is represented by elfin and stunted woods. Impenetrable brushes of gnarled alders and cedars clothe most of the slopes, and pass upwards to dwarf elfin bushes. Between this and the naked ridges stretch ragged carpets of alpine meadows. Birch woods, sometimes very dense, sometimes sparse, rise on the foot slopes and clothe the gentle rises between the lower valleys. It is only along the streams in the sheltered valleys that a really pleasant vegetation is found. There extend prosperous meadows, with patches of tall umbellifers, with groves of poplars, birches, and alders, and shrubberies of rhododendrons. This open natural park is, however, skirted by swamps, which unite to form the barren, treeless moors of the coast. Wild sheep are to be found here, as in Alaska and Columbia. This inhospitable land, infested in summer with mosquitoes, and lying under snow for nearly two thirds of the year, is suited for little else than sheep and cattle of the hardiest type. Agriculture is, indeed, impossible.

Indo-China. The lofty parallel ridges, separated by steep and narrow gorges, which form the approach to south-eastern Tibet, diverge, fan-like, in three distinct chains: the eastern chain of Annam, the central Malay chain, which extends near the Equator, and the westernmost or Arakan chain: they include the plains of Siam and Burma. Just south of the tropic, their convergence

builds up an uninterrupted and massive system of parallel folds extending from Assam to Yun-nan.

The entire region, except the Malay Peninsula, lies within the monsoon area, and is, therefore, characterized by the annual rhythm of the dry and the wet seasons. The rainfall is abundant and the temperature typically tropical. It is therefore to be expected that vegetation, while exhibiting tropical luxuriance, should reflect the well-marked monsoon rhythm: this, however, is perfectly expressed only in part of the lowlands of Siam and Burma. The landscapes which bear the stamp of the monsoon are here: (1) the savana, corresponding with that of the Sudan and South America. It is best represented on the low hinterland plateaus of Siam and Laos, and to a less degree in Burma: (2) the drier and lighter tropical forests which shed their leaves in the dry season. Teak is, in eastern Asia, the typical tree of such forests: (3) the jungle, a dry and tall deciduous scrub, some thirty feet in height, which represents here the 'caatinga' of Brazil. Besides these, and forming transitions between the teak forest, the jungle, and the savana, occur countless varieties of light tropical woods, either evergreen or deciduous, continuous or distributed in more or less extensive patches. In fact, a great portion of what is called jungle in Indo-China would be termed savana, bush-savana, tree-savana in the Sudan or Brazil.

The distribution of these monsoon formations seems to depend largely on local circumstances of soil and relief. The teak forests are best represented in the upper inland plains and foot-hills of the Irawadi, as well as on the marginal foot-hills of the middle Mekong. Savanas and jungles are representative of lower Burma and the low plateau of Siam, but their development is limited both on the seaward and on the highland side

by conditions of soil and climate. In Indo-China indeed two main landscapes strike the eye of the traveller: the rugged mass of wooded mountains through which swift and mighty streams have carved their deep channels, and the low swamps rapidly encroaching on the sea by means of the colossal deposits which are spread broadcast by the rivers when in flood. All the big rivers, Si-kiang, Song-ho, Mekong, Menam, Salwin, and Irawadi, thus create vast belts of half-emerged swamps, covered by an inextricable network of sluggish, muddy, and ever-changing tidal waterways, like the sundarbans of the Ganges. On these shaky muds have sprung into existence low, gloomy, impenetrable tangles of evergreen swamp forests, corresponding to the vargem or igapú of the Amazon, with their canopy almost resting on the water during the monsoon period. An excess of ground-water here counterbalances the effect of the dry season.

A great part of the land thus conquered by the shallow seas, is however being reclaimed by man and enclosed by levees before it has time to develop its own vegetation. Rice-fields (or 'paddy'-fields) are planted on the undried silt, and rivers are bordered by areca and other palms, bambu-thickets and groves of banana-trees. The luxuriance of these 'paddy-lands' is unbounded; areca and coco-nut palms, manjack fruit, tamarind, orange and lemon, bread-fruit, and cinnamon trees yield profuse crops. Besides rice, the land, divided as a chess-board, gives pineapple, tobacco, indigo, cotton, and all the variety of tropical produce. The waste-land remains in the state of undrained, impassable reed-swamps, where there is an extraordinary abundance of game.

The mountains of the interior hardly know a period entirely devoid of rainfall, and are therefore clad with

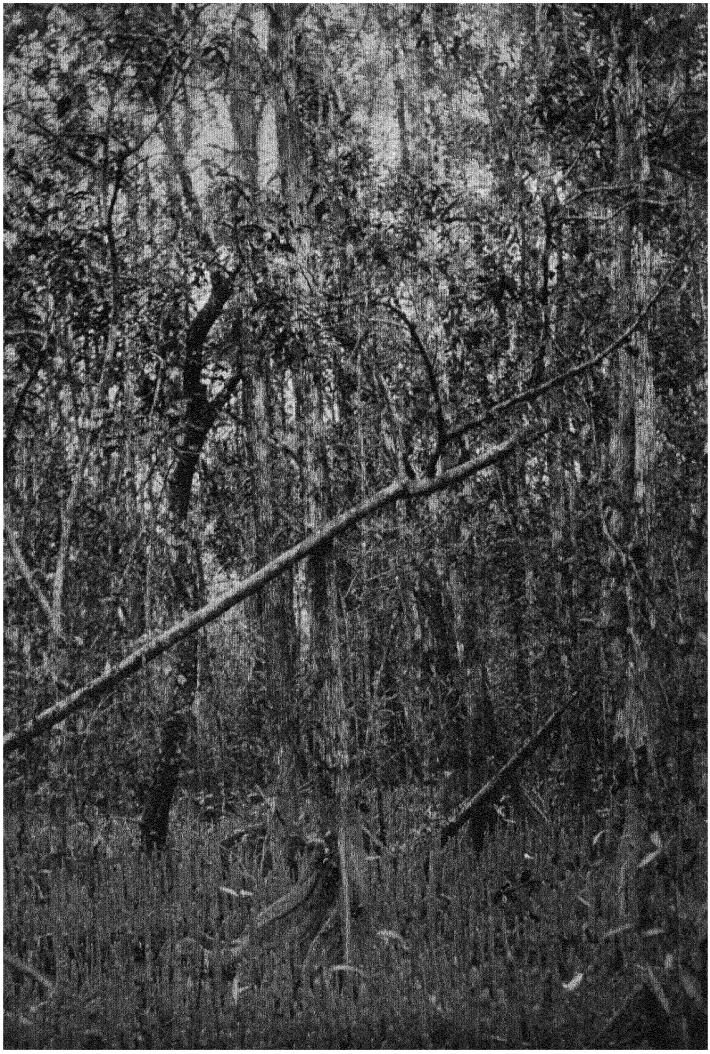


FIG. 8. The Sundarbans.

evergreen rain-forests. They offer, in their fastnesses, a veritable jumble of sharp ridges, precipitous slopes, and deep gullies, hidden beneath dense and tall forests, whose distribution is regulated by altitude. Thus the secluded valleys support on their lower slopes regular equatorial selvas, in the clearings of which equatorial agriculture is practised. The greater portion of the mountains, however, is under rain-forests of the sub-tropical type, which may be characterized by tea and camellia, though on the upper slopes, oaks and pines are to be found in abundance, and mark temperate, even northern, conditions. In the Shan states, the plateaus of 3,000 to 5,000 feet in elevation, crossed by still higher ridges, display rich grassy expanses. Buffalo, rhinoceros, boar, tiger, deer, jungle-fowl, peacock, egrets, and snipe are still found in abundance in this broken and wild region. Thus, on the sea side, the excessive ground moisture, and in the highlands, the atmospheric humidity, restrict the true monsoon type of vegetation to the plains of Siam and Burma. It is even possible that the practice of grass-burning, common to all savana lands, has favoured the extension of the jungle.

It would be difficult to exaggerate the importance of this south-east corner of Asia in the economic development of the world. Here, indeed, is said to be the original home of rice, banana, and sugar-cane, three of the most universally essential articles of diet: our common lemon and orange are found wild: similarly, the melon and cucumber are among the indigenous plants of this region. Spices such as pepper, ginger, cinnamon, and cardamom, gums as betel, &c., rubber-plants as many species of ficus, gutta-percha plants, tea-trees, camphor-wood trees, and the valuable teak-tree, are all natives here; but the enumeration of all the economic products would be too long.

It is hardly surprising, therefore, that civilizations of a high order have advanced, in the past, in the inhabitable parts of the country—Cambodia, Siam, and Burma. The paddy-lands of the deltas, despite their insalubrity, are scarcely less densely peopled than the rich lands of central and northern China. In the highlands, except for the limited agriculture practised at the bottom of the



FIG. 9. A Chinese Rice-field.

valleys, the hunter is still master of the slopes and of their forests.

Japan. The southern portion of Japan belongs to the same region as central China, whilst the northern part, or Nippon, belongs to the region of eastern Korea, and Hokkaido shares in a large measure the characteristics of Amuria.

On the whole, the main island consists of a core of

highlands or Alps, having a coastal plain or hill land of varying breadth.

Eastern Margin of the Great Central Plateau. The plateaus of Mongolia and Tibet are limited on the east by the Great Khingan and the mountainous margin of eastern Tibet. The winds, which are sucked inland from the Pacific by the excessive heating of the interior in summer, deposit much of their moisture on the eastern slope; but before reaching it, they water abundantly the hilly lands of China. The whole of this marginal region is benefited by the wet monsoons, and is fertile. That the strength and beneficial effect of the monsoons gradually decrease from south to north is partly shown by the fact that the Tibetan margin, which is abundantly watered, is ploughed by mighty rivers, whereas the Khingan escarpments, receiving only a meagre rainfall, are not deeply eroded. In winter the air is forced outwards from the cold interior, and north-westerly winds, which are very cold and dry, sweep over the marginal lands. The broad belt of lower lands, which extends from 10° N. to 50° N., passes gradually from equatorial to nearly polar conditions. Equatorial conditions persist along the deltas and marshes of the coast as far as the Tropic of Cancer. Sub-tropical nature advances as far as the mouth of the Yang-tse, while the warm temperate climate reaches to southern Korea.

Manchuria is sharply limited on all sides but one by mountains: the Khingan scarps on the west and north, the Sikhota Alin and Korean Highlands on the east and south. The vast rolling plain thus defined, lying at 500 feet above sea-level, is too low to condense a due proportion of the moisture of the Pacific winds on their way from Korea to the Khingans. It is too far north to profit much by the monsoons, but in winter is swept

by icy blasts from the north. It has therefore an extreme climate, with dry and intense cold in winter and sweltering heat in summer. Spring and summer rains are sometimes abundant and render the plain im-

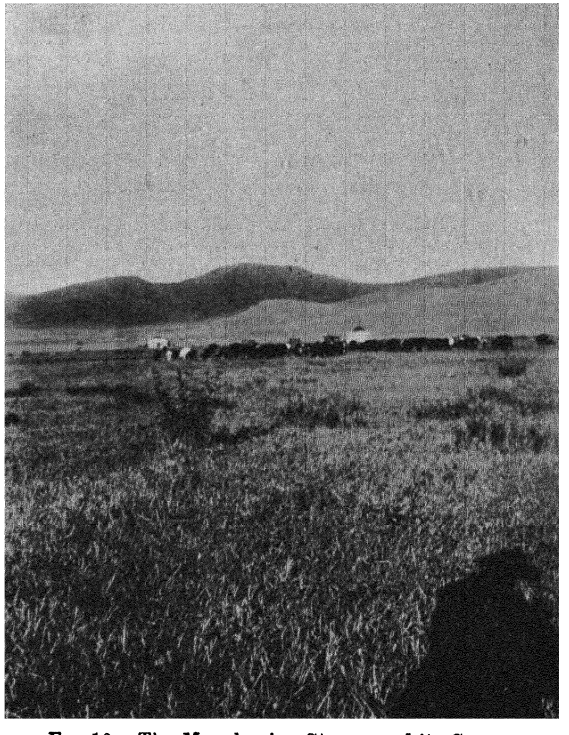


FIG. 10. The Manchurian Steppe and its Camps.

passable. Indeed, in many respects, Manchuria deserves the name of Eastern Gobi, which is often applied to it; but it also offers some analogies in respect of its situation, climate and vegetation, with the low plain of

the lower Columbia on the Canadian border. Like the lower Columbian district, it possesses a naturally fertile soil; and water, though absent from the surface, may be found generally at a depth of a few feet. Partly on account of its scanty rainfall, which does not exceed 20 inches yearly, it has remained a treeless steppe. It possesses a few centres of aridity, which may even be represented by sand-deserts, and around these vegetation is disposed in widening concentric belts of increasing fertility. The typical Manchurian steppe resembles the buffalo-grass plains, offering a low and fairly continuous level of dry grasses, interspersed, however, with various herbs, undershrubs, and bulbs, which flame into beautiful colours in spring. It is doubtful, whether climate and soil alone could account altogether for the absence of trees and shrubs in this region, but apart from destruction by the nomads, no other reason is forthcoming. There are, indeed, travellers who believe that once the Mongols cease burning the steppe and begin to plough, trees will flourish everywhere, and already in the north-west corner a sort of park steppe with small round trees may be seen.

Despite its extreme climate, Manchuria has attracted large numbers of Chinese agricultural settlers, who are endeavouring to turn the country into a rich wheat and cereal land and export the crops into Russia in large quantities. Hemp, opium poppy, and tobacco are also grown successfully, and large portions of the plain form rich agricultural districts.

East of the Sungari the land rises, gently at first, in parallel folds, towards the Sikhota Alin highlands. There is no doubt that these hills were once clad with timber similar to that of the Usuri basin, but, as usual, deforestation has followed in the wake of the Chinese

settlers, and the mixed forests of conifers and hard-wood trees are now enormously reduced, and restricted to some of the valleys: destructive floods also have arisen, and the hills have been stripped of their soil. Gradually, towards the east, with more abundant rains and a somewhat less extreme climate, forest-clad slopes of a European type, and fertile valleys like that of the Usuri, appear, and form a transition to the Amur-Usuri region. The natural wealth, both mineral and agricultural, render this district an important asset in the development of eastern Asia.

The Gobi–Manchuria barrier, the Great Khingan escarpment, being slightly higher, succeeds in wringing more moisture out of the south-easterly winds. The Khingan slopes are naturally well wooded, conifers being still the outstanding feature in forests of a European type. Much of the timber, however, has given way to cultivation and to pastures. As might be expected, the eastern slopes of the chain are richer than those facing the Gobi.

Northern China. Manchuria is separated from China proper, west of the Gulf of Liaotung, by a broken highland of moderate height, compressed between the Khingans and the sea.

In China, agriculture, continued for long centuries, has altered the natural appearance of the land to such an extent that the primitive aspect of the vegetation can only be reconstructed with extreme difficulty. Despite the severity of the winters, a fertile soil, an abundant rainfall, and an absence of protracted droughts make northern China support an abundant plant life, which naturally would be a dense forest growth. It is possible to see from what is actually left that this forest once existed and was of a northern, summer-green, broad-leaved type mixed with conifers, and so analogous to our

European type. This was to be expected from a region with a severe and dry winter. When it is considered, however, that northern China lies in the latitudes of southern Spain and the Mediterranean, and is not a high plateau, the importance of the severe winter as a controlling influence upon the kind of vegetation is at once realized.

Lured at one time of year, and by a combination of very favourable influences, into a growth of abnormal luxuriance, vegetation is at another time compelled to adjust itself to the eliminating conditions of a very trying season: a strong rhythm, even more marked here than in the coastal plains of eastern North America. It is, therefore, natural that plant life in northern China, unable through the winter limitations to assume a sub-tropical aspect, should exhibit the northern cool, temperate type in its highest activity. The vegetation of northern China represents the supreme expression of the cool, temperate, summer-green, broad-leaf, arborescent type, and is to be compared with that of the southern Appalachians and the Atlantic coast-plains of North America.

That the controlling feature of the climate upon vegetation is the severe cold weather is still further shown by a comparison with the parts of Japan in the same latitudes, which have a milder winter by reason of their outlying situation, and are free from the cold and dry northern winds from the desert. In southern Japan we find the sub-tropical evergreen vegetation fully developed; and, though of the broad-leaved, summer-green kind, the plant life of northern China has distinct relationship with more southern floras. The principal trees are no longer oaks and beeches and others familiar to us, but species of *paulownia, catalpa, ailanthus, gleditschia, sophora,* and the paper-tree or *broussonetia*

a good many of which, by reason of their hardiness, have been acclimatized in Europe and are becoming familiar features of our parks and gardens. Further inland, however, one sees that the flora of Amuria, similar to that of Europe in many respects, has been carried along the range of the Khingans south to the Tsin-ling-shan: there oaks, hazels, birches, and conifers are to be found.

In the east of northern China is an undulating lowland, the Yellow Basin, covered with enormously thick layers of a fine, porous, and extremely rich soil of a yellow colour, the incomparable 'yellow earth' or loess which is deeply furrowed by rivers and roads. No soil more suitable for the growth of cereal crops is found anywhere, and it vies with the 'black earth' of Russia in fertility. Further down the valley, arms of the river flow above the general level of the land across the alluvial plains, and are partially and with difficulty kept within bounds by means of levees, hence periodical floods cover the region, often with the most disastrous results.

Both the yellow belt and the delta are utilized for agricultural purposes to the fullest extent, and consequently support a dense population. Barley, millet, wheat, maize, cotton, tobacco, and hemp are abundantly cultivated, and yield admirable crops. As might be expected, the loess belt, naturally rising above water-level and consequently cultivated more easily, was also settled and utilized before the flood portion, which offers greater difficulties.

The hill-land of Shan-tung has been entirely deforested and opened to agriculture. The hill-land west of the Gulf of Liaotung is a beautiful park, with rich meadows and patches of coniferous woods.

In a sense, the Chinese nation was cradled in the

Yellow Valley. There it is that the Chinaman developed his wonderful skill as an agriculturist, unsurpassed by any, and got those qualities of thrift, endurance, fortitude, and perseverance which are his characteristics.

Central China. In comparison with northern China, a more equable and milder climate, with a more abundant rainfall, ranging from 40 to 60 inches yearly, and regularly distributed over spring, summer and autumn, together with an immunity from the cold and dry blasts from central Asia, are the principal features of the large portion of China which stretches from the Tsinling-shan and the hills north of the Lower Yangtse to the mountainous region of Tongking and Yun-nan.

The Tsinling range establishes an effective and sharp barrier between the Mongolian type of climate and mild and rainy central China. The steep northern slopes of the Tsinling, owing largely to deforestation, are mostly covered with a scattered bush, in which one discovers the Mongolian representatives of oaks, birches, and conifers, and even *paulownia* and *catalpa*. Woods are mostly restricted to the upper valleys, and the slopes facing south are much more abundantly watered and considerably milder. They display already the chief characteristics of a moist sub-tropical climate with dwarf palms, large ferns, bambus, and an approach to temperate rain-forests. Towards the east, however, the distinction between the two regions of northern and central China is not so sharply drawn along the low divide between the Hwang-ho and the Yangtse basins.

In respect of its climate, central China lies under very much the same conditions as the southernmost Atlantic States of North America, though here the monsoon is the great factor of plant-life. Everything points to its having been originally a region of extensive rain-forests

of a sub-tropical, mostly evergreen character, abundantly mixed with conifers and summer-green trees; but it is difficult, at the present stage of intensive agriculture, dating back so many centuries, to reconstruct exactly the original distribution of the different kinds of forests and pastures. The growing period extends over the larger part of the year, and is hardly interrupted by a short and temperate period of rest.

Bananas and similar plants, as well as the tall tropical palms, are absent, but hardy species of palms, bambus, and ferns, even small lianas and epiphytes, and such trees as camphor-wood, camellias, especially tea-trees and liquidambars, are well represented. This is best seen in the mountains in the west, which display in their forests a magnificent profusion. Conifers of a southern type, such as gingko and cypresses (and even pines), mark the temperate nature of the climate, of which one is further reminded by the presence of winter-bare trees, such as chestnuts and maples. In short, it is legitimate to picture the primitive vegetation of central China as resembling that of the Alto Paraná and Paraguay regions of South America. Within such an immense area, however, strong variations are certain to arise between the north and south, the far interior and the coast districts, between the Alps of Hupe, the low valley of the Yangtse, and the hill-land of Hunan and Kiangsi.

The fact that central China is the meeting-ground of the northern and sub-tropical floras produces a bewildering wealth of plant-life, hardly surpassed in any other region of the world. Separate mention should be made of the western part, which includes Yunnan, Kwei-chou, and western Sechwan. Proceeding westward, the land becomes extremely broken. Increasingly loftier mountains attract an almost excessive rainfall, and the

profusion of nature simply knows no bounds, whilst the rapid and vast changes of elevation create an immense variety. From the lowlands and the hill-lands, with their mixture of pines and palms, of camphor and other lauraceous trees, camellias and tea, and the hanging vines of the wistaria, one passes upwards into the difficult and as yet little explored mountain region. In its forests, vegetation simply runs riot. Amid the remarkable and unsurpassed diversity of precious timber species, the gorgeous wealth of rhododendrons and azaleas, magnolias and bambus, fuchsias, roses and chrysanthemums, and the countless beautifully blossomed plants generally known to our gardeners as japonica, are found here in their native haunts. A belt of temperate, summer-green forests, including well-known trees, such as oaks and alders and hazels, is followed further up by dense forests of stately conifers. The alpine zone, with a large variety of primroses and gentians, of ranunculus and anemones, far surpassing the beauty of our own alpine meadows, extends to the line of eternal snows.

As regards agriculture, the range of produce is no less striking: rice and cotton, mulberries and tea, poppies and beans, wheat, maize, pulses, onions, indigo, sugar, hemp, and tobacco, furnish profuse crops under the skilled and patient labour of the Chinese. In brief, it is hard to find any portion of the earth, including Europe, where the diversity and abundance of fruits and other produce are greater than in central China. For thousands of years the natives have been an essentially agricultural population and have carried their methods of cultivation to a high degree of perfection. Especially worthy of notice are the valley of the Yangtse, those of Hunan and Kwang-si, and the terraced region of Sechwan.

Agriculture has always remained the primary and

almost exclusive occupation of the Chinese, other industries being subsidiary to it and ranking far behind it in importance. No nation has made more of, and so thoroughly appropriated, the soil: nowhere has rural life and organization been stronger: in a way, the chief of the state is but a glorified peasant. In no large natural region can the influence of agriculture, and through it, of the geographic environment, on the mode of life, institutions, organization, morals, religion, arts, and poetry, be traced so clearly as in China.

Malay Archipelago. By their situation within the equatorial belt, the islands of south-eastern Asia: Sumatra, Java, Borneo, the Celebes, and the Philippines, to which may be added the Malay Peninsula: enjoy an equable equatorial climate, with an abundant rainfall distributed regularly throughout the year. We may, therefore, expect to find here all the profusion of tropical nature. The equatorial selva is indeed the rule here. Only minor climatic variations, along with the nature of the relief and soil, determine departures from this highest and heaviest type of vegetation. All these islands possess a skeleton of mountains, either in long barrier-ranges, as in Sumatra and Java, or in centres from which chains radiate, as in Borneo. In Sumatra and Java, those ranges are high and continuous enough to drain the bulk of the southern monsoon, and thus render the northern slopes comparatively dry. West Java is also moister than the eastern portion of the island, and consequently the alternation of dry and wet periods tells more on the vegetation. This contrast can be traced throughout the different belts of altitude from the sea-shore to the tops of the mountain screens. Thus, in the west and south, the lower slopes are clad with a heavy growth of luxuriant selva: in the east

and north the forest type is much poorer and lighter, tending towards the leaf-shedding type of the teak or 'djati', with which it is abundantly intermixed. The



FIG. 11. Undergrowth of Evergreen Equatorial Forest in Solomon Islands.

succeeding belt on the moister side consists of evergreen, temperate rain-forests, not unlike those of south Chili and, corresponding to the cloud-belt,

characteristically overgrown with hanging mosses. On the drier side, the middle zone is constituted by a park landscape of grasslands interspersed with woods. Their dominant tree is a casuarina, locally called 'tjemoro', whose leafless and shadeless twigs have the appearance of our humble horsetail. The ground vegetation consists of small bushes with a leathery foliage, suggesting the poor ground brush of a thin pine forest. Approaching the tops of the mountains, the trees and even the elfin scrub disappear to make way for the meagre grass-lands.

The well-watered plains, which are fully developed only on the northern side, are the seat of an active agriculture, in which tobacco and coffee predominate.

Intermont plateaus intervene frequently between the southern scarps and the opposite slopes: they are covered with poor pastures.

Borneo, as a whole, is surrounded by wide coastal plains, most of which, on the Asiatic side, are covered with fields and fallow-lands. The central highlands are densely wooded and, as far as has been ascertained, include a lower zone of equatorial selva and a middle belt of temperate rain-forest carried far into the upper valleys. Above 7,000 feet the ridges are covered with coniferous woodlands passing to elfin woods, and, at higher levels, to elfin scrub and alpine brush.

The narrow plateaus which form the backbone of the Celebes display typical savanas.

It is a striking fact that the alpine vegetation of dwarf shrubs and cushion-plants, with their tiny, leathery, or wool-clad leaves, strong roots, and gorgeous display of flowers, which are usually associated with ice and snow, should be found here characteristically represented at comparatively low levels, under the Equator, and entirely free from snow. It is equally remarkable that

the upper limit of forest-growth is very low as compared with the corresponding levels amid the continental ranges of the equatorial belt. The same phenomena are still more forcibly exhibited in the lower South Sea Islands. They all tend to show that the strength and dryness of the winds are the real influences which limit tree-growth and shape the alpine vegetation on the mountains, as they do in the polar regions.

To the enormous and varied resources of their islands, the Malays have greatly added by sea trade in the past. The wealth of these populations at once agricultural and sea-faring was very considerable, and their influence spread all over the eastern seas. To this day the Malayan islands are among the most densely populated. Mysterious ruins of truly magnificent cities testify to the high measure of civilization reached by those people long before the advent of Europeans.

India may be said to be entirely governed by the monsoon, whose effects are largely controlled by the relief of the surface: thus the area beyond its influence in the north-west is extremely arid, and the plain of the Ganges which lies open to the south-east monsoon is fairly well-watered on the whole; but the winds gradually spend their moisture on the way westward. Approached from the south-west, the semi-arid table-land of the Deccan is robbed of a large portion of its water by the screen of the western Ghāts, which thus separates it from the luxuriant Malabar coast. The southern part of the plateau, however, merely from its geographical position, enjoys a longer wet season than the northern half and is correspondingly more fertile. In the Himalayas, the eastern half is abundantly watered, while the north-western part only receives a scanty balance of the moisture.

The strong rhythm of the two seasons is thus felt throughout the whole of India; but on the outskirts of the area, along the Malabar coast, in the north-eastern Himalayas, Assam, and western Burma, the period of drought is so short as to be practically without influence. Consequently these regions are the seat of evergreen wet forests. Throughout the rest of India, the ground is sharply contested between tree-growth and scrub; but where tree-growth is possible, it bears the stamp of the seasonal contrast and foliage is shed during the dry period. The winter colds are unimportant as a factor in vegetation, except among the mountains. Central India is not, therefore, a region of continuous and dense forests, but offers a varied landscape whose type oscillates between tropical deciduous woodlands and the poor acacia scrub.

The Ganges valley has been cultivated so long and so intensively that its original state can only be guessed at; at present it is well-nigh treeless. Its fertility comes from its alluvial soil and from the abundant water-supply afforded by its rivers, the Ganges and its tributaries, which are utilized for irrigation. Rice, wheat, opium, indigo, and, in some parts, cotton, are the staple crops which now support a large population; but it is not unlikely that it was formerly a savana interspersed with various kinds of rain-green woodlands.

The combined delta of the Ganges and Brahmaputra presents an aspect similar to that of the Burmese and Indo-Chinese deltas. The lower swampy alluvium, covered by an impenetrable mixture of evergreen jungle and mangrove, have hitherto proved too strong for human powers, and have challenged human enterprise much as the corresponding swamps of the Mekong.

The vast table-land of the Deccan, difficult of access

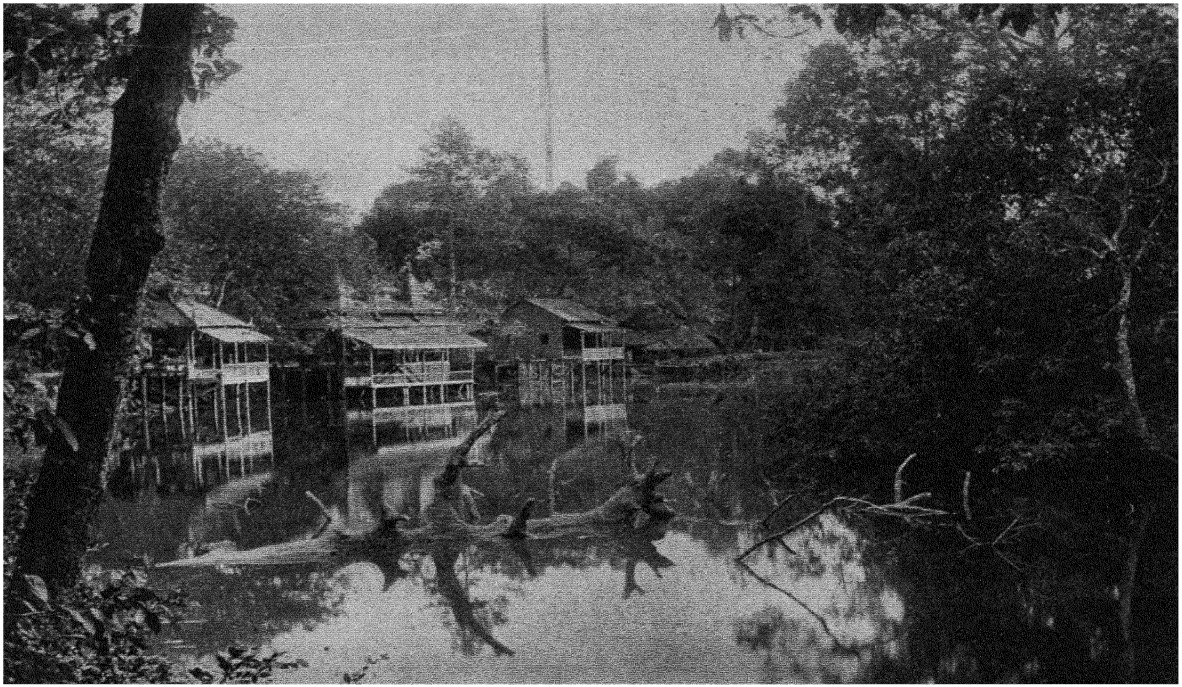


FIG. 12. **A River Scene in Burma.**

and seamed by deep gorges, is less than 3,000 feet high. It may be divided, broadly, into a north-west drier part and a south-eastern portion where the rainless period only extends over two or three months; but the driest area stretches in a belt at the foot of the western Ghāts. Much of the original character is still preserved in the mixed woodlands of teak and other deciduous trees, which however, do not form a continuous cover, but are intermingled with large expanses of semi-arid scrub. Though the Deccan is said to be destitute of true 'caatinga' formation similar to what exists in South America, Africa, Australia, and Siam, it is evident that some of its deciduous jungles and woodlands, depending upon analogous climatic conditions and offering the same vegetative characters, may be classed under that type. The gorges, which the rivers have cut for themselves below the level of the plateau, are densely wooded. A large portion of the dense and tall, drought-bare scrub is only new growth consequent upon the destruction of forests, which is natural in a country with a comparatively dense population. Among the economic resources of the woodlands are teak, sandal-wood and cedrela, the bastard cedar, whilst cotton is extensively grown.

The escarpment known as the eastern Ghāts leads one from the central plateau to the low and narrow coastal plain of Coromandel. This is a dry and hot, sandy tract, mostly covered with thickets of thorny evergreen shrubs, equivalent to the 'restinga' formation of the Brazilian shores. The evergreen jungle, however, gives way, at the deltas of the main rivers, to fertile tracts which are suggestive of oases.

The west coast feels, to a much less degree, the seasonal monsoon rhythm and the influence of the dry season. The drought lasts less than two months and the

atmospheric humidity continues to remain high. Of peninsular India, this stretch of coast-land, at most fifty miles broad and rising in abrupt scarps at the back, is the only one which admits of high tropical rain-forests. These forests, albeit they do not attain the luxuriance of the selvas of south Sumatra, display a great exuberance and all the essential features of the typical rain-forest. The hot and wet region of Malabar is continued into south-western Ceylon, where the character and profusion of the equatorial belt are further emphasized, and the coco-nut palm forests are famous.

In the north-east of India, the mountain forests of the Arakan-Assam system, as well as those of the south-eastern Himalayas, exhibit a wet evergreen, but distinctly sub-tropical, type, with a great wealth of forms. The admixture of leaf-shedding vegetation is fairly strong, and trees of a more familiar aspect, oaks, pines, and magnolias, are abundantly represented. Here tea is as profusely grown as in southern China. The north-eastern mountainous region of India, which is also the region of heaviest rainfall in the world, is most appropriately compared with the middle belt of the Montaña at the head waters of the Amazon.

A cross-section cut through the south-eastern portion of the Himalayas would show a lower tropical belt, about twenty miles broad, rising from the plains to 1,000 feet, of loose forests (chiefly of sâl-tree) and rich, swampy jungles and grasslands, with enormous bambus and tall palms.

The sub-tropical belt, which reaches an altitude of 6,500 feet, presents the wet, evergreen aspect, but includes trees of a familiar type, such as pines and live oaks, celtis, olive-trees, sumacs, and others.

A temperate zone of non-coniferous, largely deciduous

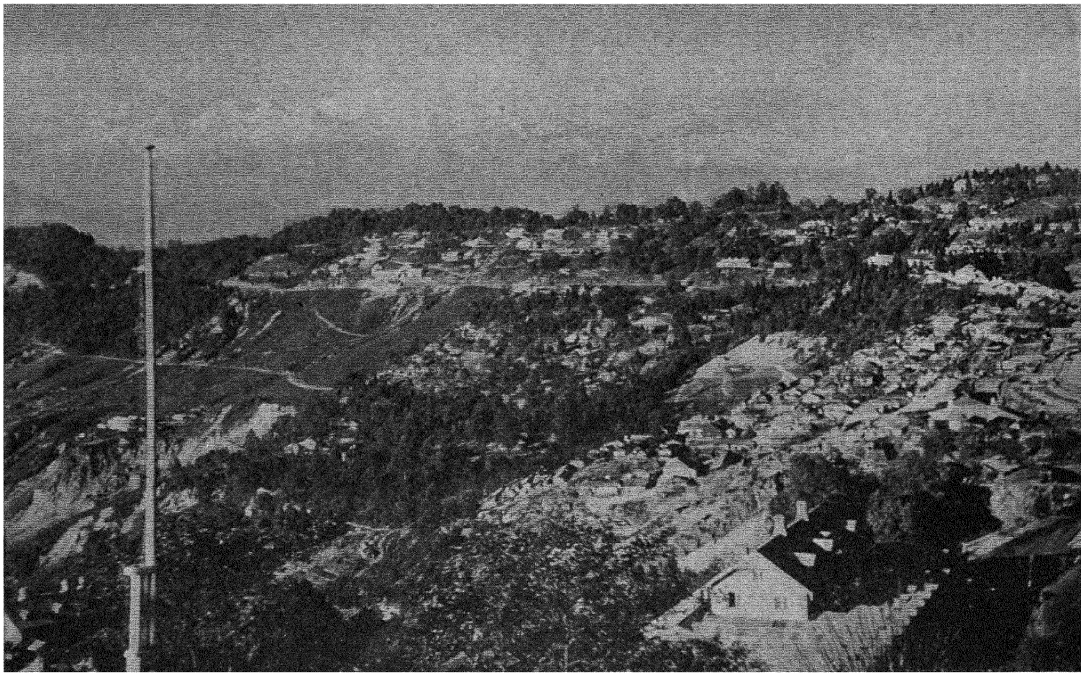


FIG. 13. The Himalayas, from Darjiling.

forest-growth, succeeded by a zone of conifers and rhododendrons, stretches up to 11,500 feet. The alpine zone of pastures and shrubberies, of screes and herb coverings, ascends to 16,000 feet.

On the north-west, the Himalayan vegetation, especially in the lower reaches, loses more and more its sub-tropical character and profusion. In the Indus district the climate is decidedly dry, and the vegetation assumes increasingly, at least at the lower and middle elevations, a somewhat mediterranean aspect with stout, evergreen, round-headed, hard-leaved trees, walnuts, oaks, pines, firs, and deodars. Many of the slopes are either completely denuded or thinly dotted with a loose evergreen scrub equivalent to the Mediterranean 'garigue'. The woods are loose, often scattered, with hardly any undergrowth or ground vegetation. This district is extremely suitable for the cultivation of maize and wheat.

The **Indus Desert** is really part of the vast system of tropical deserts of the Old World and the easternmost corner of the arid belt of the Sahara-Arabia-Persia series. The bulk of the monsoon from the Arabian seas is deflected towards the east by the Vindhyas, leaving but an unimportant part for the plain of the Indus. Thus the rainfall which is always irregular hardly rises above ten inches yearly. The centre of this area is formed by the hot desert of Thar, a low and monotonous plain, one of the dreariest places on earth. It is approached through concentric belts of increasing barrenness: a main zone may be distinguished, extending on the west to the foot of the Baluchistan highlands, and on the north to the foot of the Himalayas. This zone may be compared with the Somali 'nyika', and is covered with a scattered and herbaceous vegetation, with a thin dotting of thorny

shrubs, most of which venture to assume their scanty foliage only during the short rainy period. Among them may be recognized familiar denizens of the African semi-deserts, e. g. the Arabian acacia and the tamarix, and along the margins of the dry river-beds, fig-trees and Euphrates poplars. Oases, with palms, are to be found in fair abundance; but the life of this area is due, and restricted, to the Indus and its tributaries, fed by melting snows of the Himalayas, and dry most of the year. By means of auxiliary canals and irrigation ditches, the productive surface has been extended in the vicinity of the rivers, and wheat can be grown with success. In short, a parallel may be drawn between this Indus belt and Mesopotamia; but here the importance of the Himalayan snows is such that the network of rivers and canals allows of a fairly dense human settlement.

From prehistoric times, the immense wealth and infinite resources of India have attracted invaders, conquerors, immigrants, adventurers, and travellers, by land and sea, from all points of the compass. In the Deccan, the eastern slopes and plateaus came to be densely peopled, whereas the slopes of the western Ghāts, with their dark forests, remained comparatively uninhabited. Geographical changes have also occurred which have moved the centres of population. There was a time when the Indus was a more powerful stream than it now is, and fertilized a much vaster area of its valley. Even the Thār desert is strewn with ruins of forests, canals, and cities, testifying to its former importance.

Iran is a natural region formed by a vast plateau, defended on all sides by a continuous rim of mountains: on the north by the chain of the Elburz Khorassan merging into the Hindu Kush; on the east by the broken Baluchistan highlands; on the south and west

by the great barrier of Zagros, rising precipitously from the narrow coastal shelf of the Persian Gulf.

Its central situation in the midst of arid lands, and its girdle of lofty mountains mark it, from the first, as a very dry territory, whilst its elevation, which, in the south-west, is considerable, and its extra-tropical position, make it a land of extremes of heat and cold. Except in the north-west, the yearly rainfall remains under ten inches and is very unreliable. The worst feature is the icy northern blast which sweeps unchecked across the eastern plains. Here again, therefore, the life of the country depends largely on the snows of the marginal mountains, and of the two chains which cross the plateau. These feed meagre streams, which dry up and lose themselves at no great distance from the foot-hills.

Under such circumstances, forest-growth is out of question; even large tracts of continuous grassland are scarce. Loose colonies of plants form the essential feature, and these are necessarily confined to isolated localities of limited extent, conditioned solely by the nature of the relief and the soil. The dry winds keep the vegetation low: trees require the shelter of the mountains, but low shrubs, scattered and deciduous, able to tap the deep-seated ground-water, are best adapted to these conditions, and with them an ephemeral flora, which bursts forth with the occasional showery spells and then dies. Perhaps the chief characteristic of the Persian vegetation is the extraordinary wealth of thorns and prickles: about five hundred thorny plants have been counted here, including small trees, shrubs, under-shrubs, and perennials.

An important distinction must be drawn between the broad valley of Shiraz-Isfahan, which rises like a vast hummock between the southern chain of Iran and the

interior chain of Kerman and Yezd, attaining an elevation of over 4,500 feet; and the plains of Khorassan, Kuhistan, Registan, and northern Baluchistan which lie to the north and east. The valley stretches in a south-east to north-west direction and penetrates into the mountains of Armenia. It is very cold at night, and sometimes covered with snow in winter. In the centre, broad surfaces are thinly dotted with tufts of dry, short grass, and with stunted, leafless thorn-bushes. In places the growth of dwarf herbs becomes almost continuous and forms a meagre steppe. During the rainy spells, however, the landscape is strangely enlivened by a carpet of low herbs with gorgeous flowers which burst forth from the barren soil as though by magic. This ephemeral flora of annuals is quite European in its composition and appearance.

The influence of the mountain streams does not extend far in the plains. These streams are absorbed by the sands and evaporated at no great distance from the foothills; but before losing themselves, they create a fertile belt of terraces, alluvial fans, flats and marshes where life is concentrated. In consequence, towns are always found in the vicinity of the mountains. In past ages the natives developed great skill in the search for water and the appropriation of the ground moisture, and the necessity of walling in the gardens against the winds was early recognized. Orchards have been planted with most of our European fruit and other deciduous trees: such as the walnut, apricot, peach and almond, plane, Euphrates poplar, &c. The gardens are renowned for the incomparable beauty of their roses, but the tops of the trees above the sheltering walls are soon killed by the dry winds. Such vegetation is also represented in the valleys of, and in the belt around, the mountains

of Kerman and Khorassan, whose limestone slopes are generally as porous and barren as those of Zagros.

Very different is the appearance of the desolate plains which lie at a lower level east of Teheran and north-east of the Kerman chain. This portion of Persia is much poorer in water and more extreme in climate than the plateau of Shiraz-Isfahan; in fact, it corresponds to the arid alfa plateaus of north-west Africa. A persistent and strong dry wind from the north keeps down all tree-growth and is the specific feature of the climate. Vast expanses of sand-wastes and salt-tracts are well-nigh devoid of vegetation or peopled by straggling colonies of salt-bushes. Other areas support a loose brush of tamarixes. Broad stretches of rubble, especially in the eastern part, grow only solitary bushes, thorny, leafless, and stunted, and tufts of stiff, wiry grass.

Life is confined to the immediate margins of the rivers which diverge from the Hindu Kush, or, again, to the valleys of that belt of low hills which separates Kuhistan from Afghanistan. In the middle of the wide expanse of barren gravel lies the oasis known as Seistan, a very rich country due to the convergence of the Hindu Kush rivers towards the lowest point of the relief at the foot of the central chain of hills. Here are exhibited the characteristics of the northern vegetations, and agriculture is of a northern type; cereals and fruit-trees are profusely grown under shelter. Seistan was known in the past as one of the granaries of central Asia, but with increasing dryness, its limits have contracted considerably. Swampy tracts between the affluent rivers are covered with jungles of tamarixes, similar to those of the Tarim desert.

Farther south, the sub-tropical character is asserted clearly in the oases, which like those of Africa and



FIG. 14. An Oasis in the Desert. Iran.

Arabia are graced by clumps of date-palms. The mountainous southern portion of Baluchistan and Mekran continues the narrow coastal shelf which stretches at the foot of the wall of Iran. Outside the oases, the vegetation is limited to poor and scattered scrubs of thorny, leafless bushes, among which the acacias are now characteristic.

While the high plateau of Shiraz occasionally affords a meagre fodder to passing camels, and is pleasantly diversified by oases, the desolate plains of Khorassan are unfit for anything. The valleys of Afghanistan radiating from the Hindu Kush are peopled by villages dispersed along the bottoms only: the slopes are singularly devoid of vegetation.

In the chain of Zagros, which continues the Taurus and forms the south-western escarpment of Persia, the climate still retains a mediterranean character but towards the east becomes increasingly dry. The limestone rock, by its sheer slopes and the porous nature of its rubble, adds greatly to the aridity of the country. In many respects the Zagros chain strongly recalls the barren region of the Illyrian Karst. Most of the steep slopes are entirely denuded; and it is only on the terraces and in the depths of the secluded longitudinal troughs, sheltered from winds and favoured by local accumulations of ground-water, that vegetation appears. The live oak and other evergreen, hard-leaved trees and shrubs give it a decidedly mediterranean stamp. Loose formations of low shrubs fringe the valleys on the gentle lower slopes; at times there is enough water to allow the trees to close in and even to crowd as light woods. Frequently, indeed, these secluded troughs and terraces reveal a veritable luxuriance in their fruitful orchards of olive, apricot, apple, peach, almond, pomegranate,

walnut, and other trees. Cereals, especially wheat and maize, are grown with the best results. Cypresses and plane-trees add to the unexpected beauty of the mountain oases. In addition, meadows are often found in these remote hollows; they are sufficient to support the herds of the nomads in their yearly migrations from the winter grazing grounds of the lowland to the summer mountain pastures: but, as a rule, the limestone rock, with its fissures and its stony wastes, is too dry for continuous swards of grass. This mediterranean karst vegetation, concealed on the terraces and in the valleys of the Zagros margin, stops at the Straits of Ormuz.

Briefly, then, the roughly triangular plateau of Iran defined by the Elburz and Khorassan chains in the north, the Zagros–Mekran–Baluchistan ranges in the south, and the Baluchistan mountains in the east, falls into quite typical regions; the lofty valley of Isfahan–Shiraz, the lower and drier salt depressions of Khorassan–Afghanistan to the north-east, the dry and rocky semi-tropical hilly tract of Baluchistan in the south-east, the karst-like range of the Zagros on the south-west, and the desert coastal shelf of the Persian Gulf. Local names connote some of the distinct types of regional vegetation: thus 'dschaengael'—whence the name jungle has arisen—clearly designates loose scrub-land and also scattered wood: 'saerhadd' connotes the elevated summer-pastures.

Agriculture in Persia is necessarily restricted to very few and limited localities, the largest cultivated area being found in the trough of Seistan. The main wealth lies in fruit-trees, many of which are undoubtedly indigenous. Several plants of economic value are found wild, such as the pomegranate, the fig-tree, and the white mulberry; the mountain pastures support sheep,

which give valuable wool: hence two important industries are those of silk and wool rugs. Here, again, the alternate availability of lowland and highland pastures drives the shepherd regularly from one to the other, and causes nomadism.

Of the northern chain of Iran and the declivities which face Turan, mention has been made already. Towards the Caspian, the rain-bearing winds become more generous, and that part of the Elburz which lies along the southern margin of the Caspian is fairly abundantly watered: hence the sharp line drawn between the northern and southern slopes of the chain; while the Persian side is arid, the Caspian side is well-wooded. The tree-growth is decidedly of northern temperate, winter-bare type, with a rich variety of species, and here occurs the easternmost limit of our common beech. The plane-tree, the walnut, the ash, the hornbeam, several kinds of oaks, maples, and poplars, and, in addition, the stately zelkova, compose the forests, which, to our eyes, would thus have quite a familiar aspect. A characteristic shrub is the box, which forms almost exclusive scrub at higher levels in the centre of the range. The winter appearance of the Caspian forests, with bare trees, and snow lying on the ground, differs very little from that of the mountain-forests of central and eastern Europe; the ground vegetation in summer reveals plants equally familiar to us: in short, the southern margin of the Caspian is in striking contrast with its drier surroundings.

Iran is in the belt of lands which have been gradually drying up. Life has always been more concentrated in the elevated plain of Shiraz and Isfahan, and in the north-west corner towards Armenia. The Iranians were early devoted to agriculture, which they

indeed raised to a sort of religion: they were among the first users, if they have not been, as they claim, the actual inventors, of the plough and of the windmill: their skill in discovering and utilizing water was famous. The empires which successively arose and declined there exercised their influence far eastward on China and India, westward on Europe, and made the most valuable contributions to civilization.

Mesopotamia. Under this term is here included the region which extends along the foot of the Zagros from the Straits of Ormuz to the highlands of the Euphrates: bounded on the west by the escarpment of the Syrian desert, it includes the middle and lower valleys of the Euphrates and Tigris. The climate may be best compared to that of the Mediterranean, but with accentuated heat and drought; the winter is comparatively milder, but not so rainy as in the Mediterranean; the summers are dry and scorching.

The great feature of this region, however, is the background of limestone highlands, which prove to be the source of its fertility. The relatively abundant water, which falls on the northern and north-eastern mountains, sinks rapidly to a lower level, and feeds the two main rivers, Euphrates and Tigris. It further washes down from the mountains a rich calcareous silt, which is deposited in the plain, and renders its soil extremely fertile, while, at the same time, these alluvia are periodically flooded by the water from the melting snow. Vast marshes are thus created on the level tracts, but the ground-water is never very deep.

All these circumstances compensate for the dryness of the climate: the rainfall which remains under ten inches, is irregular and limited to the winter months. In these plains, vegetation naturally depends on the

amount of water in and on the soil, more than on the atmospheric humidity: the topography and the soil entirely control the character of the natural vegetation.

Where, for geological and topographical reasons, the level of the ground-water is deep, the vegetation, entirely dependent upon the climate, is extremely scanty, low, and stunted, even of a desert type, consisting of a very thin dotting of bare, thorny, gnarled bushes, intermixed with tufts of dry, stiff grass: indeed, the aspect is then to be compared either with that of the barren Atlas plateaus or with that of the rubble of Baluchistan. This dreary landscape is only brightened in winter and spring, when showers determine the germination of the millions of seeds lying dormant in the sand, thus suddenly called to extremely active and short life. The Garmsir is indeed the land of 'ephemeral' plants, which impart to the landscape an indescribable beauty. Large tracts, however, keep their fertility for a longer time, owing to the retentiveness of the soil and to the presence of water near the surface. In this case, vast meadows are created which also benefit by the snow-fed floods of spring, and pass into steppes on the higher ground as do those of upper Mesopotamia.

Of the tracts depending entirely on ground-water, the date-palm is the characteristic tree: it marks the irrigated ground and the banks of rivers and canals. Its growth is encouraged by the natives on account of its valuable products; every part of it becomes useful. Under its shade are found admirably cultivated gardens and fields where fruit-trees, from coffee and vine to peach, almond, and fig, are grown; wheat and maize, millet, tobacco, rice, cotton, and hemp also yield profuse crops.

The ranges of hills which rise isolated in upper Meso-

potamia exhibit a marked mediterranean character: live oaks and fig-trees are to be found everywhere, but man has reduced most of the original woods which clad their slopes to the condition of the evergreen scrub known in the Mediterranean as 'māquis' and 'garigues'.

Upper Mesopotamia deserves a special mention here. On account of its hilly nature, it lies in a zone

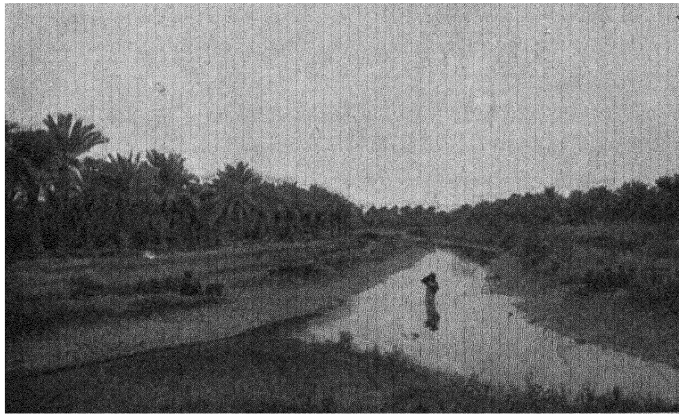


Fig. 15. The Jubailah Creek—Mesopotamia. Date-palms on the left.

of more abundant rainfall, not exceeding 20 inches yearly, and mainly limited to winter. This hinterland is indeed entirely mediterranean in respect of its climate and vegetation. It is bounded on the north by the Armenian Taurus, and sinks, on the south, to the level of the lowland by an escarpment giving the impression of hills.

This piedmont terrace, the centre of which is Diarbekir, was originally the land of the live oak and the

fig-tree, but is now laid under fields of maize, wheat, tobacco, and rice, fruit orchards, olive- and vineyards. It is continued on the south-east by the foot-hills and foot-terraces of the Zagros chain.

The part of the Garmsir which forms the shelf of Zagros to the Persian Gulf is arid and scorching. The vicinity of the mountains, however, determines the formation of numerous water points, which are so many date-palm oases, each a nucleus for a village.

The past fertility of Mesopotamia, with its 'garden of Eden', was due to the utilization of the waters of the twin rivers Tigris and Euphrates by means of irrigation canals and ditches, and to careful drainage, which formed one of the most admirable engineering works the world has ever seen. On these were founded the powerful civilizations which succeeded each other in the course of centuries, with their countless cities and their all-important influence upon the history of mankind. It is now proposed to restore the irrigation systems and thus to open a new future to Mesopotamia.

Asia Minor is a vast and irregular plateau, with an average height of over 3,000 feet, and encircled by mountains. In the west, it opens by broad valleys to the Mediterranean; on the east, it is bounded by the complicated mountainous region of Armenia. The mountain-chains which cross the plateau, like the other features of the relief and the bounding walls on the north and south, are directed mainly east and west. The mountain-rims on the north, west, and south deprive the centre of Anatolia of most of the climatic advantages which would accrue from its position in the midst of the great inland seas. Bereft of rains and of the regulating influence of large sheets of water, the high plateau is arid and extreme in its climate. Its irregular rainfall is limited

to less than ten inches, the bulk of which falls in winter, partly in the form of snow. On account of this and of the altitude, the atmospheric moisture is extremely low. The main portion of the plateau is treeless and barren. Even for large compact masses of shrub-lands and for permanent and continuous expanses of grass these conditions are too severe; and centres of aridity are formed by salt marshes and sand wastes.

Anatolia, therefore, is not fit for any other vegetation than a ragged covering of scattered brush and shrubby perennials. The inland ranges are barren: an abundance of thorny plants (shrubs, under-shrubs, and creepers), a development of a woolly covering on the leaves of the lower plants, and a general dusty-grey aspect of the whole plant-world, are characteristic features of the landscape for the greater part of the year; but, during the irregular spells of rainfall, the growth of the rain flora is quite as vigorous as in Persia.

Up the slopes of the inland mountains, some of which attain a great elevation, the poor scrub and ragged carpet of low, woolly perennials of the plateau pass gradually to similar wastes, in which the alpine character of the scattered plants, and the disappearance even of the isolated shrubs, constitutes the only difference.

While this description is true of the central plains, the general aspect gradually changes towards the west, where the country becomes more broken. The very scattered brush closes into a loose garigue or a continuous maquis, according to the condition of the soil. In short, the landscape gradually assumes the mediterranean appearance of evergreen shrub- and wood-lands. Now the live oak, the olive, the orange-tree and laurel, the fig-tree and, westward, on the upper hills, even pines, occur in increasing abundance. The rainfall has increased to

such an extent that the cultivation of wheat is rendered possible in the valleys.

The southern margin of Anatolia displays the same mediterranean character. Along the Taurus, evergreen woodlands, often reduced to the condition of maquis and garigues, are the dominant feature: but cypress, cedar, and black pine, together with the Cilician fir and junipers, the remains of a once more luxuriant forest, are abundantly intermixed in the broad and hard-leaved woods; they even constitute independent patches in the fastnesses of the mountains. The upper slopes with their alpine herbage afford summer pastures for cattle.

The aspect of the northern slopes, facing the Black Sea, which may be called Pontus or Pontis, is different. In every respect the climate and the vegetation of these slopes are identical with those of the South-Caspian barrier of Persia. Sufficiently watered, yet experiencing distinctly the rhythm of hot and cold seasons, the forests are bare in winter, and their appearance and composition is similar to the central European woodlands. However, the plane-tree, the horse-chestnut, *pterocarya*, wild walnut, and many others, exemplify the much greater variety of the trees, and the conditions, milder than in Europe, which prevail there. To find a vegetation exactly equivalent to that of western Europe, one has to climb up to a middle zone characterized by the oak. Further up again, a subalpine shrub belt is formed by rhododendrons and bilberries, and leads to alpine pastures.

The highlands which rise to the east of Anatolia, and penetrate far into Persia under the name of Armenia, are not so well provided with water as the Pontic slopes. Their vegetation presents a transition stage between the mediterranean and the northern types. Originally well-wooded, but formed often of limestone, they have been

deforested largely by incessant streams of immigration. Their lower slopes are pretty bare, only supporting the scattered maquis, but the upper slopes often shelter coniferous forests.

The country is rich in the valleys, where orchards and gardens are found in abundance. In addition, the upper valleys afford excellent summer pastures with all the glory of our alpine swards, where the shepherds, and part even of the agricultural population, migrate in the hot weather. Although it is probable that climatic changes have taken place in this region, the bulk of Asia Minor, by reason of its aridity, could never become the centre of an indigenous civilization, and of great empires, like the valleys of Mesopotamia and Egypt. By contrast, the fertile but hilly coast fringes permitted the development of small separate nationalities, subsisting partly on mediterranean agriculture, partly on sea-trade. Each of these in turn rose to some degree of prosperity, and exercised a real influence in history: each of them also naturally expanded towards the hinterland, across the mountains, and brought under their sway the adjacent portions of the arid territories with their itinerant tribes. Apart from the frequent passage of migrating nations, the history of hilly Armenia is, in the main, a tale of endless struggles between the settled agriculturists of the lower terraces and plains, and the wild shepherds of the upper valleys.

Turan extends from the Kirghiz steppe to the mountains of Khorassan, and from the Caspian to the Pamirs and the Tian Shan. It is formed by the bottom of a dried-up sea, a vestige of which remains as the Aral. A low plateau, the Ust-Urt, separates it from the Caspian.

By reason of its feeble altitude as well as of its central

position, Turan receives rain from none of the surrounding areas. The winds from the north, which deposit their scanty moisture on the southern and eastern mountain ranges, sweep past the depression without any benefit to it. Its climate is therefore truly desert and extreme, open to excessive variations from the hottest summer to the coldest winter, from scorching winds to icy gales. In this respect, it differs from the sub-tropical deserts. Turan owes what fertility it may possess to its two large rivers the Amu and the Syr.

Vast territories are left entirely plantless, indeed lifeless. They are impassable stretches of moving, heaving sands, and where these are relatively settled, vegetation has succeeded in gaining a foothold. It consists of a brush, now scattered, now in thickets of sand-shrubs and small bushy trees, the whole aspect of which recalls tree-heaths or brooms, the trees possessing tiny leaves or none. The best representative of this flora is the saxaul, fifteen to twenty feet in height and less than a foot thick, whose grey trunk, curved and twisted, resolving itself into numerous scaly, thin, short-segmented twigs, makes it resemble a besom. It stores water in its bark, wherein also the green matter which represents the absent leaves is hidden: other trees have the appearance of the tamarix. This brush effectually binds the sand, and advantage is taken of the fact to resist the encroachments of the shifting dunes by means of extensive plantations.

No less formidable than these 'red and black deserts' are the vast level wastes of saline clayey soils, sparsely dotted with dwarf bunches of mostly leafless plants. The vegetation consists of salt-bushes, dusty-grey wormwood, spreading besoms of bare, broom-like under-shrubs, or crawling and thorny stragglers. Such also is the

dreary landscape of the tracts bordering on the Caspian and covering most of the low Ust-Urt plateau between that sea and the Aral, where, however, conditions are made worse by the unfavourable nature of the soil, which, besides being salt and destitute of moisture, often contains poisonous substances.

Through the deserts of Turan, the Amu, and the Syr Darias stretch two thin lines of oases. The other rivers lose themselves in the sands, after breaking up into fertile swamps.

Along the southern and eastern margins of Turan extends a belt of terraces, foot-hills, and alluvial tracts, whose naturally fertile soil derives moisture not only from the vicinity of the highlands, but also from their snow-fed rivers: in fact, this belt owes its existence wholly to the mountain streams. It is lined with little oases along the foot of the Khorassan ranges and expands in the valleys of the Heri-Rud, Murghab, Amu, Zerafshan, Syr, and Chu. A good soil and a sufficiency of water, notwithstanding the extreme but not hostile climate, put those rich valleys in striking contrast with the forbidding solitudes of Turan proper. The land of Fergana bears comparison with the plains of Lombardy, and the upper valley of the Amu is still broader and richer. In the past, these border-lands were prosperous and each drop of water was carefully appropriated; each of the valleys mentioned was a centre of civilization. Powerful empires in Fergana, Sogdiana, Bactria, and Wergian, with splendid cities such as Kria, furthest Alexandria, Samarkand, Bactra (modern Balkh), Merv, and Herat have left imposing ruins; but the increasing dryness of the climate, coupled with invasions of the nomad shepherds from the desert, gradually extended the limits of Turan. To this day, however, portions of

the large valleys display luxuriant orchards, where most of the mediterranean produce and fruits are grown: mulberry, apricot, plum, almond, apple, as well as grapes, melons, maize, rice, wheat, and cotton; and tall, columnar poplars are everywhere in evidence. In respect of its agriculture, therefore, this belt is related to the mediterranean regions, of whose climate it presents a drier and more extreme variety. This comparison would be still more justifiable at the time of the greater extension of the inland seas.

The winter and spring rains provide temporary grazing grounds for cattle, sheep, camels, and ponies, which migrate in summer to the snow-free and luscious mountain pastures. Here again, as all over central Asia, the annual rhythm of migration from lowlands to highlands and back is strongly marked.

Turkestan Highlands: Tian Shan, Alai, Badakshan. Compared with the surrounding lowlands, the Tian Shan highlands appear as a delightful oasis, both on account of their varied scenery and of their verdant vegetation. They drain the north and westerly winds of what moisture they may possess, which usually amounts, however, to less than 20 inches yearly. The atmosphere is generally clearer than in the Siberian highlands. Owing to the northern and western origin of the moisture-bringing winds, the southern and eastern districts are drier and poorer than those of the north and west, and over the entire area, northern and western slopes are the richer and moister.

With the rains, snows, and mists, tree-growth is possible here at altitudes exceeding 5,000 feet and up to 9,000 feet; but it is exclusively coniferous. Poplars are seen only in the depths of the river-valleys, and walnuts and other fruit-trees grow exclusively in gardens. The

forests, which consist of spruce and a kind of Sabine juniper, are seldom dense, but towards the east and south they become decidedly diffuse and often fail completely. They are generally not continuous, but are interrupted by pastures, and largely restricted to the valleys. There is a fundamental difference between the short and dry swards of the steppes and the long, close, and lush meadows that extend below, through, and above the timber-belt, and often replace it entirely: the latter partake of the luxuriant character of our meadows. They are beset with a number of tall herbs and shrubs, such as the rose and barberry, wild geraniums and poppies, peonies and gentians, blue bells, wild onions, &c.; there is quite a wealth of garden-plants, which grow wild, such as asparagus, candytuft, chrysanthemum, columbine, heliotrope, pansies, rhubarb, peony, phlox, tulips, and crocus.

The alpine meadows, which extend beyond the belt of junipers, display an exuberant beauty equal to the best flower-tracts of our Alps; but there are no swamps or bogs, no heather and bilberry moors, no rhododendrons. Below this elevated garden, however, the valleys display only drier steppes, which gradually pass downwards to dusty, scattered brushes, and, sometimes, to entirely plantless gorges. On the Mongolian side, the steppes ascend much higher than on the west, and are often replaced immediately by alpine pastures without the intervention of a tree-belt.

In some respects, then, the Tian Shan recalls the elevated natural parks at the head-waters of the Colorado, in the Rocky Mountains, and provides summer pastures for the cattle and sheep, and quarters for the shepherds, of the plains. The portion which penetrates far into the Mongolian desert is naturally very

much poorer, and grows quite arid towards its eastern extremity.

Kirghiz Steppe. From north to south, east of the Ural-Caspian line, there is a gradual impoverishment of plant life from the wet Siberian taïga to the sandy deserts of Turan. The wooded swamps of Siberia give place to a flat or rolling country, where the marshes are reduced to hundreds of small lakelets in the troughs and hollows, and the climate is neither so rainy and cold as that of the taïga, nor so dry and hot as that of Turan. This is the region of steppes.

The line between the forest and the grass-land is not hard and fast. Over a belt 200 to 300 miles wide, the transition is made by a park landscape, in which birches are scattered over the prairie in groves, groups, and sometimes in woods. The innumerable marshes are marked by fringes of giant cow-parsnips, day-lilies, willows, and poplars. Meadows and herb-mats are interspersed in the steppe. Trees disappear gradually towards the south; the steppe assumes a typical, dry aspect with its low covering of wiry grasses, in the interstices of which the soil may be seen. Henceforth, it is a heaving ocean of grass, the appearance of which changes wholly from season to season: verdant and flowery in spring, brown and parched in late summer, dusty-grey with woolly wormwood in autumn and winter. It sometimes conceals rich black earth and loess, which forms a heavy and retentive soil.

The climate, though not so hostile as that of Turan, has an irregular rainfall oscillating between 10 and 20 inches distributed over spring and summer, with droughts recurring every few years. Generally about two-thirds of the year are very dry, and excessive alike in cold and heat. (The combination of this type of

climate and fine soils, all over the world, results in a similar absence of trees and bushes, and the development of the dry grass-land known as steppe or prairie, of which an abundance of bulbs and tubers is a feature.) Saline wastes grow more numerous southwards. They soon spread over vast areas towards the Aral region, and are accompanied by the usual thin covering of salt bushes and tamarisks. In the middle of the steppe, the hilly district of Akmolinsk produces a recurrence of fertility which has gained for it the name of 'little Switzerland'.

The limited grazing capacity of any given area induces the natives, who depend for their living almost exclusively on their cattle, ponies, and sheep, to migrate frequently as their pasture-grounds become exhausted, and thus to lead a wandering existence: in summer, when the steppe is dried up, those who are not far from the mountains, journey thither.

The remarkable fertility of the black earth and loess, however, now fully recognized, has led to the opening of the steppe for agricultural purposes, wherever water is available and irrigation possible. A large portion of this region may become, in course of time, a wheat district as rich as that of Nebraska, California, and the Red River, the Plate, or Australia, or, nearer at hand, the Russian steppe.

On the south-east, the Kirghiz steppe is continued into that of northern Sungaria and northern Mongolia. This long grass belt, stretching between the desert on one hand and the mountains and forests on the other, was one of the natural highways whereby the nomadic populations of wild shepherds from further Asia slowly reached Europe, driving their herds before them.

Siberian Highlands. A broad and complex system of

highlands of moderate elevation, which includes the Altai and Sayan chains and the Trans-Baikal highlands with the Vitim and Aldan plateaus, separates Mongolia and Amuria from eastern Siberia.

As may be expected from its continental situation, it is a region of severe climatic extremes and reduced atmospheric moisture. The rainfall derived from the northern and eastern quarters occurs chiefly in summer, but there is a heavy snowfall in winter. The moderate height of the mountains, sufficient to condense a large proportion of the vapour of the winds, allows some of it to penetrate further south than would such a lofty barrier as the Kuenlun.

As each successive ridge athwart the southward track of the winds levies its toll of moisture, the lower limits of rains and clouds are gradually raised from ridge to ridge, with the result that the southernmost valleys remain dry. Correspondingly, the levels of fairly luxuriant vegetation recede farther and farther up, going towards Mongolia; and for the same reason, the southern slopes are drier than those facing north. Thus, whilst the Siberian slopes are abundantly wooded and linked uninterruptedly with the Siberian taïga, the Mongolian valleys display their forest belts only on their upper slopes.

Conifers are the only trees that can constitute forests among the Siberian highlands under such extreme conditions: birches and aspen, which accompany the rivers, are of little importance as forest-trees, and mostly to be found at lower levels, though on the sunny southern slopes of Trans-Baikalia the birch may reach an elevation of 4,600 feet. Between the Siberian taïga and the highland forests there is this difference, that the latter do not exhibit the stunted, even dwarf aspect, which

characterizes tree-growth on the East-Siberian plateaus; on the other hand, especially on the southern slopes, they are seldom dense and close: they have that scattered appearance which characterizes the forests on the Rocky Mountains and Sierra Nevada. The undergrowth, which is mostly grassy, is far from being thick and impassable as in Sakhalin.

Scots pines, with a mingling of birches and aspen, come next to the steppe vegetation on the western and southern slopes. Farther up, larches predominate, but often mix with, or give way to, Siberian firs and spruces. Many humbler plants, with which we are familiar, occur here: there is an abundance of aconites, peonies, willow-herbs, geraniums, cow-parsnips, bright-flowered groundsels, &c., in the meadows and pastures that frequently interrupt the clear forests. Some of the vivid flowers of the steppes are found far up the wooded slopes. Stone-pines form the upper tree-limit at altitudes varying from 4,000 feet on the northern slopes to 5,000 feet on the southern slopes. They penetrate in groves and clusters among the upper hill-pastures, where such shrubs as rhododendrons and such flowering herbs as globe-flowers, columbines, anemones, violets and gentians, poppies and saxifrages, remind one of the Alpine meadows of Europe. The pastures of the Siberian highlands, in contrast with the dry and short swards of the steppes lower down, seem like hay meadows.

Thus there seem to exist, in these highlands, two aspects or landscapes gradually merging into one another: the northern or Siberian, more densely wooded, and connected with the Siberian taïga. This is typically exhibited among the Baikal highlands: the other, the Mongolian or southern aspect, may be seen characteristically displayed south of Baikal, in the districts of the

Orkhon and Tola. It consists of an admixture of pastures and scattered woods.

Approaching Amuria, some of the broad-leaved, summer-green trees of the latter region, such as the walnut, now begin to appear, while denizens of the northern tundras and mountains penetrate far south along the naked ridges of the Jablonoi. The plateaus of Vitim and Aldan, which slant from the edge of the Jablonoi towards Baikal, are of the nature of park-like, subalpine pastures and moors, comparable with the plateaus of British Columbia.

The importance of the Siberian highlands, especially of the southern slopes, is great in the life of the Mongolian tribes, for the upper slopes provide excellent summer pastures at a time when the adjacent steppes are scorched and dry. Populations leave the burnt steppes every summer and betake themselves and their herds to the fresh and luxuriant grazing-grounds of the mountains, and this is the easier on account of the scattered nature of the forest belt. On the northern side, the colder climate and the darker forests remain serious obstacles for the herdsmen. Hence the tide of nomadism, which rises every year from the scorched plains on the south up the southern mountains, is arrested by the forests more than by the mountains themselves. There is no apparent reason why some kind of agriculture should not be practised locally along the rivers. Wherever water is available, the soil offers a generous reward to human efforts, but this is true only of the valleys, for the upper slopes are too cold for profitable cultivation.

Mongolia. That vast inland basin, which stretches from the Khingans to the Tian Shan and Pamirs, and from the Siberian highlands to the Altyn Tagh, is

considered here as one geographical unit. Mongolia forms the largest unbroken portion of it. Towards the west, the great ranges of the Tian Shan and the Altai divide it into the separate basins of the Tarim, Sungaria, and Kobdo.

Completely enclosed by mountains, the central plateau is practically shut off from outside influences. Rainless for the most part, it undergoes without mitigation the alternations of intense cooling and heating, and is swept, according to the season, by icy or scorching winds, neither of which bring rain. What water may be found within the basin is mostly due to the snows of the surrounding rim of mountains.

The Han-hai is not an absolute desert over its entire area, but rather develops around certain centres of greatest aridity, the most important of which are to be found in the Gobi or Shamo, in the Takhla Makan, and in Sungaria.

Such centres take the form of stony wastes or of seas of moving sand-dunes alternating with salt tracts of various extent: they are wellnigh plantless. In the desert of Kami, says an explorer: 'Siliceous soil, sand, stones, with scattered blocks of loess, here and there the bones of a dead camel or horse, were all that met the eye. Not a tree, not a shrub, neither bird nor beast, not even a lizard, gave life to this dismal waste. The ground was burning hot; even night brought no relief. Terrible storms whirled clouds of sand along. . . .'

Around those forbidding areas, in belts that meet each other to cover the largest portion of the plateaus, extend semi-desert wastes of rubble, gravel, and coarse-grained sands, where scattered tufts of dried-up grass, one foot high, intermingle with *Compositae*. Predominant among them is the sage-like *artemisia* or wormwood, which also

characterizes the semi-deserts of Nevada, Colorado, and Arizona in western North America, as well as the circum-desert belts of northern Africa. Depressions and dry river-beds, where some ground water remains during the greater part of the year, are marked by a taller and thicker growth of grass; a species that attains large proportions in favourable situations is the kamish. There are very few of those strange succulent, bulbous, or tuberous water-storing plant-forms of the American and African deserts: tree and bush vegetation is represented by solitary small trees or occasional thickets at the foot of a hill or in the dry bed of a temporary river, where rhubarb may also be found wild. These trees are held in great veneration by the natives. The usual flora of small plants, which may lie for years in the seed-stage and burst into an ephemeral life only after the casual rains, is not lacking in Mongolia; in season, one-flowered tulips occasionally adorn the ground with fragrant and beautiful carpets.

The true steppe constitutes another belt outside those just described. It extends in a narrow strip along the foot of the mountains carpeting their foot-hills and penetrating deep into their valleys. All but dry and apparently dead in summer, it displays a beautiful mat of blooms in spring. In this region, the oases are usually disposed in a string along the marginal mountain-chains; they develop where the snow-fed rivers dry up or disappear in the sand shortly after leaving the hills. To the north of the desert, their vegetation is distinctly of the northern type. They are recognized in the distance by screens of gaunt poplars and willows, elms and ashes, all summer-green trees with which we are familiar; and such shrubs as dog-rose, bramble, raspberry, and honeysuckle would remind us of home vegetation, while the tall

reeds which mark the water-points are identical with those of our own country. On the southern side of the Han-hai, at the foot of the Nan-shan, plant life has some distinct mediterranean features, both in the natural and the cultivated vegetation.

Apart from these concentric belts the various regions of the Han-hai possess an individuality of their own. The Tarim basin is related in some degree to the low-lying deserts of Turan as regards its flora. The nucleus of it is the deadly sea of shifting sands of the Takhla Makan, while its margin is formed by a ring of swamps, which mark the places where rivers lose themselves. Extensive brushes, ranging from dense tangles to scattered heaths, constitute a cheerless vegetation; and bushy poplars resembling straggling birch-bushes, small trees such as tamarixes and saxauls, gnarled and stunted, either leafless or with heath-like scales, alternate with reeds, rushes, and coarse grass. This jungle also fringes the uncertain course of the rivers, and is tenanted by deer and tiger, but serves for winter grazing grounds.

The alluvial tracts of the rivers make a chain of oases round the desert outside the ring of marshes: groves of tall poplars and willows occur at intervals and shelter the villages, around which cultivation of cereals and fruit-trees of a mediterranean type is carried on. This forms the inner route of the caravans, continued along the Nan-shan and the Tsin-ling-shan, to the Yellow River.

Beyond a belt of porous and arid gravel downs, one reaches a broken line of loess terraces, which are more or less planted with maize and fruit trees, and support agricultural villages, joined by a second caravan route. Ultimately among the mountains, the heads of the valleys, thanks to fair summer rains, provide abundant

pastures, when the lowland grazing grounds are dried up. Hence they are tenanted in summer, and the temporary villages at the foot of the grazing slopes are connected by an outer route. Wild sheep and ibexes, hares, wolves, and bears are found here.

A similar disposition is seen in the southern part of Sungaria, beyond the barrier of the Tian Shan. The desert nucleus is not so extensive as in the Takhla-Makan. Quasi-desert wormwood-brush-wastes cover a large portion of northern Sungaria, and gradually merge into the steppe which clothes the foothills and lower valleys of the Altai range: thence the steppe skirts the southern margin of the Siberian highlands, penetrating deep into the valleys and up to the belt of luxuriant mountain pastures or, eventually, rising to meet the forests.

The secluded Kobdo basin is an outlier of the Mongolian steppe far among the highlands. Its landscape is much more prosperous than that of Sungaria, containing only a few arid centres of limited extent, while its grassy downs are interspersed with some luxuriant meadows. Tree-growth remains confined to the river-margins and to the oases, or again is relegated far up the mountain slopes. This is a rich cattle country, where ponies, camels, and sheep find abundant maintenance during the winter months. The character of the oases is now decidedly northern.

The foot-hills and marginal belt of northern Mongolia display a landscape similar to that of Kobdo. On the north-eastern and eastern margins, along the Khingans, the summer rains spread to some distance from the mountains, correspondingly widening the belt of steppes. Between the latter and the desert area lying to the west, the larger portion of the Gobi falls into the zone of scattered grass and wormwood-brush, which in late

summer and winter is as bad as the true plantless desert. This is also the case with the Ordos plateau, which lies inside the loop of the Hwang-ho.

The alternate availability of summer pastures in the mountains and winter pastures in the lowlands has determined the nomadism of the Mongolians, along the whole margin of the plateau. This nomadism is mitigated by the fact of a double chain of oases, where permanent cultivation is possible, an inner line of swamps, and the line of loess terraces, which are often transformed into fertile orchards and corn-fields.

On the two sides of the desert the character of the natural and the cultivated vegetation is different: on the northern side it is frankly northern, on the south it is mediterranean. Thus the lower valleys, south of the Tarim, display rich orchards of apricots, mulberries, melons, grapes, pumpkins, walnuts; and fields of maize, similar to those of Fergana and the upper Amu. This is the more readily explained by the fact that the present desert is the bed of a former inland sea whose last and feeble vestiges are found in such erratic and vanishing sheets of water as the Lob-nor, the Ebi-nor, the Bagrach-kul, and others. Long after the disappearance of the sea, a more generous climate prevailed over the broad plains strewn with large lakes. Water was more abundant than it is now, and large rivers wound far into the plain, while agriculture supported comparatively dense populations: important cities also were engaged in active trades. The gradual drying up continuing, forced the cities nearer and nearer to the mountains, burying the old ones in the sand. The lofty chains increasingly grudged their scanty waters to the plains, and the populations had to depart with their herds, to follow the broad belts of steppes between the snows and the deserts,

pouring westward into Europe and eastward into China.

Tibet and Pamirs-Tsaidam. Enclosed and traversed by the loftiest and most formidable mountains of the world, Tibet consists of a succession of parallel valleys choked with the glacial wastes of their dividing ranges up to an elevation of 15,000 feet above sea-level, thus

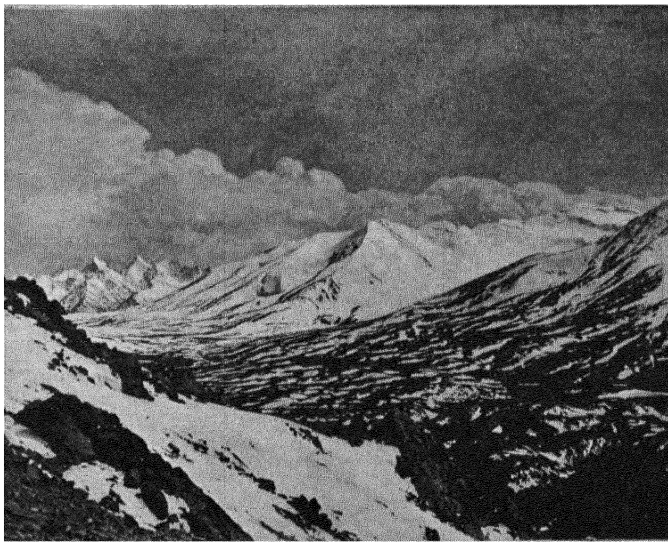


FIG. 16. 'The Top of the Last Pass'.

forming a series of wide, flat plateaus, separated by long ridges. The mountain-chains converge towards the west and lead through a row of stupendous gullies, still partly occupied by glaciers, to another region of broad and level floors or 'Pamirs' of the same origin as those of Tibet, to which, therefore, the name may be conveniently extended. Towards the east the Chinese rivers, fed by the monsoon rainfall, have cut for

themselves gigantic chasms and eaten their way into the heart of the plateau, partly clearing away the glacial wastes.

Tibet is not entirely rainless, but receives a large proportion of its scanty water in the form of snow. The north-western half of its area appears to be drier than the southern and eastern portions. It is open, by reason of its altitude, to an excessive evaporation and radiation. The climate is extremely cold, but relieved in summer by some warm days, though terrific snow-gales sweep across its surface in winter. The soil, which consists mostly of glacial and alluvial rubble, shingle and gravel, naturally adds by its excessive porosity to the climatic dryness; only the fine silts and clays along the rivers and around the lakes possess a natural fertility. Tibet may be described, on the whole, as a cold desert.

Over vast expanses the rubble and gravel may be entirely plantless. The finer soils support a thin sprinkling of tufted grasses and a few other rosette herbs, but trees and shrubs are absent. The bands of alluvia along the rivers often permit of the development of short pastures, and even mats of dwarf grasses of an arctic-alpine type. Special or strange plant-forms are rare, and there does not appear to be the wealth of tuberous and bulbous forms which characterize the South-American puñas: even the large cushion plants do not seem to be recorded as striking features. Reed and rush-swamps also occur near the rivers and lakes, but peat-bogs are not reported. Most plants are dwarf and crawling, or in spread rosettes, and forms above one foot in height are rare. Not all parts of Tibet, however, are equally barren: going eastward, the fertility increases and grazing grounds are better. At the head-waters of the various Chinese rivers, the alpine meadows are extensive and generous;

those of the shores of the Kuku-nor are particularly beautiful, and wild and tame yaks, wild and tame sheep, wild asses, antelopes, and other animals, find here ample food.

Towards the south, the more sheltered plains occasionally support orchards of fruit-trees, and cultivation becomes possible around Lhasa. This is due to its situation and lower altitude, as well as to an increase in rainfall and to more moderate winds. The north-western portion is the driest, and is almost entirely destitute of plant-life: the intervening ranges are bare and largely covered with snow and ice.

The Pamirs proper, though perhaps not so bleak as north-western Tibet, display a similar vegetation. In summer, the herds of the Kirgkiz nomads graze the pastures of the alluvial tracts, but beyond these meadows the porous glacial bottoms offer nothing but a rugged carpet of dry, coarse grass-tufts or crawling bushes.

Forests of conifers penetrate very far up the deep and narrow valleys of Kashmir and Ladakh, which are drained by the Indus. Beyond the forest limits, which here oscillate about 12,000 feet, trees continue to within a short distance of the glaciers themselves. They are poplars, willows, and other low, small-leaved, summer-green trees, which generally herald the approach of villages and are, indeed, mostly planted, though clusters of them may yet be found among rich meadows at the bottom of alluvial sections of the valleys, where they form delightful park-landscapes. Other meagre shrubs, resembling brambles and brooms, now and then close into a loose scrub, while the crawling and spreading juniper may be strewn over the bare lower slopes. Long tracts of these valleys have their flanks entirely denuded; bare platforms, shelves of rubble and waste, or naked gorges

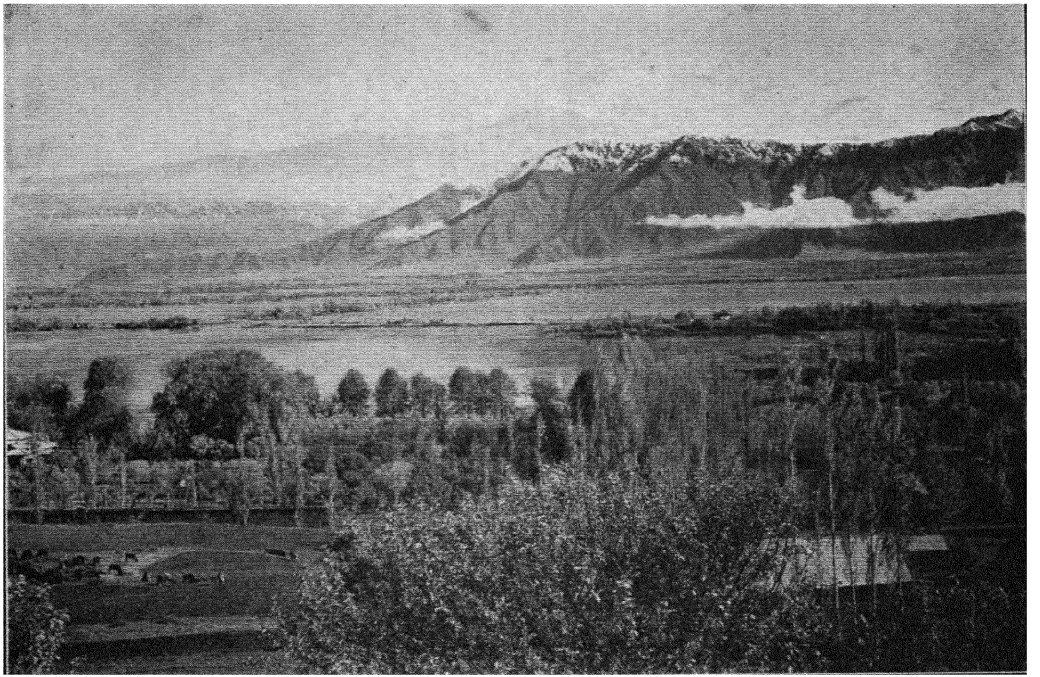


FIG. 17. Dal Lake, Kashmir. Poplars on the right, planes and willows near the lake.

and some have floors of loose and dry pastures of tuft-grass. Meagre crops of barley and vegetables are raised almost up to the foot of the glaciers on their alluvial fans; terraces are resorted to for the purpose of irrigation. These valleys are well sheltered, and perhaps unusually mild, considering the altitude; yet because they receive only a very scanty rainfall and depend exclusively on their ice-fed rivers, vegetation is limited to the floors, the more so still on account of the steepness of the slopes.

Tsaidam, in the north-east corner of Tibet, is intermediate in elevation between it and the Gobi. It is a secluded and desolate waste of salt swamps and loose brushes of tuft-grass, intermixed with lifeless deserts, but, though treeless, it does not completely exclude scrub vegetation: a few shrubs, such as tamarisks, charmiks (*lycium*), with their edible berries, nitrarias and buckthorns sometimes twenty feet high, ascend to altitudes of 9,000 and 10,000 feet.

Being absorbed entirely in the bitter struggle against nature, the Tibetans, who have remained primarily shepherds, have received civilizing influences from the surrounding countries without contributing anything of importance to the progress of mankind.

CHAPTER II

NORTH AMERICA

Two large bodies of land like North America and Eurasia, placed in similar situations and possessing broadly similar relations to air and sea currents, are bound to show a great similarity in the main features of the distribution of climate, and of life: an increase

of the intensity and total amount of plant-life from north to south, from centre to margins, with a maximum in the south and east: a western fringe more equable

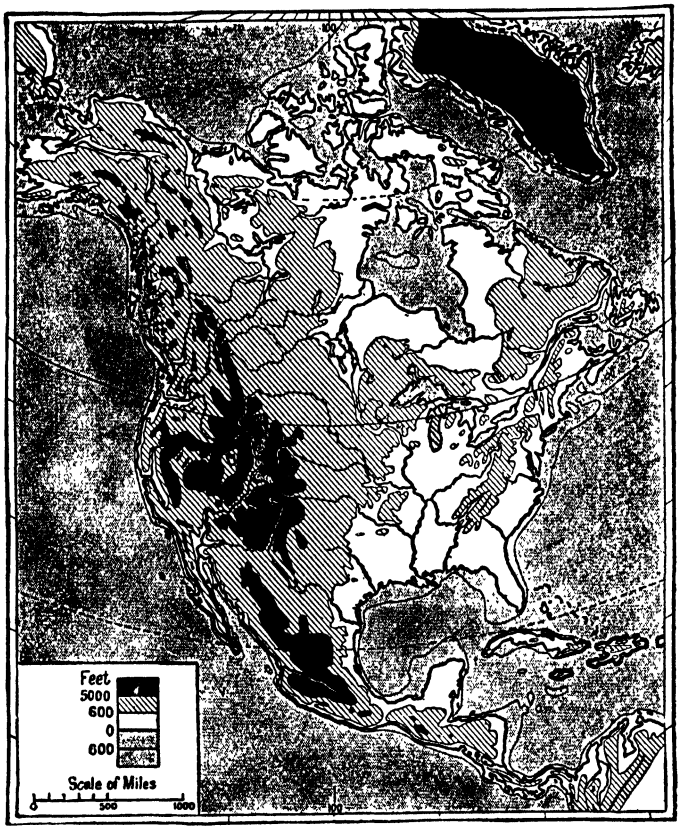


FIG. 18. Physical Features of North America.

and moderate in climate than the central and eastern portions at the warm and cool temperate latitudes. North America, however, is a smaller continent, and its relief is not drawn on the gigantic scale of that of Asia,

hence the contrasts in the distribution and forms of life are less emphatic and sharp.

The main features of the relief of North America are

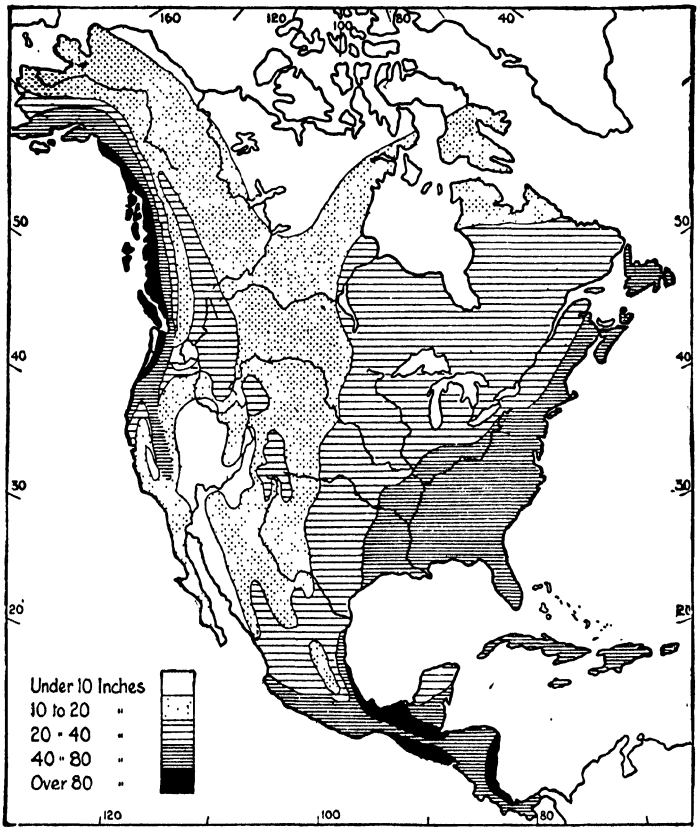


Fig 19. Mean Annual Rainfall of North America.

directed from north to south; while in Asia they run broadly from east to west, and grass and desert belts also stretch in a meridianal direction in the western continent.

Whereas in Europe the absence of high altitudes allows the moisture of the westerly winds to spread far into the continent, in western North America the interposition of a multiple barrier of lofty mountains keeps that moisture for a narrow fringe and leaves the interior quite arid. On the east, the Appalachians correspond in some measure with the Chinese Alps, but being

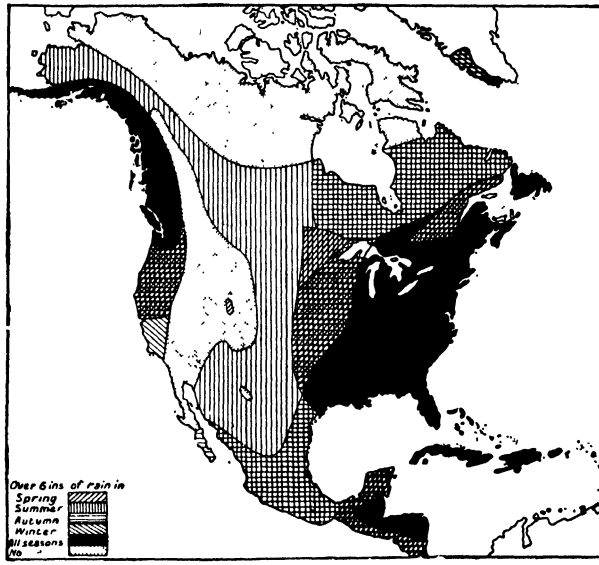


FIG. 20. Seasonal Distribution of Rainfall in North America.

much lower they are not so effective a barrier in keeping the rains out of the middle of the continent. The free communication that exists between the polar seas and the Atlantic, in contrast with the narrow gates of the Bering Sea, is also probably an important factor in reducing the temperature over the north-eastern portions of the New World, and carrying far south the

limits of the cold deserts and of the northern coniferous belt.

Tundra Region. The polar margin of the North American vegetation is characterized as in other continents by the treeless tundra. From west to east of the continent the isotherms are driven gradually further south, and the northern belts of vegetation are correspondingly lowered in latitude on the Atlantic side. Thus the northern limit of trees which, on the Mackenzie,

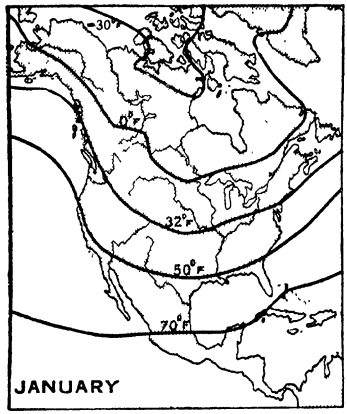


FIG. 21. Mean Temperature of North America in January reduced to sea-level.

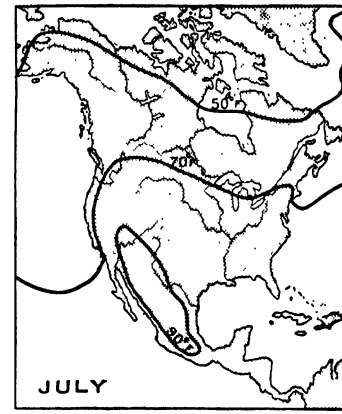


FIG. 22. Mean Temperature of North America in July reduced to sea-level.

runs near the Arctic coast, not far from 70° N., is driven south to about 55° N. in Labrador. This line marks also the southern limit of what is really treeless tundra.

In Alaska the tundra occupies a narrow strip of coast along the Bering Sea: on the northern coast it covers the polar slopes of the northernmost branch of the Rocky Mountains: from the Mackenzie River eastward, its southern limit strikes inland across the lake region to reach Hudson Bay at Fort Churchill. It extends, as

a coastal fringe, to the Arctic islands, and reaches a great development in western Greenland.

The specific feature of the American tundra, as compared with those of Siberia and Greenland, is the

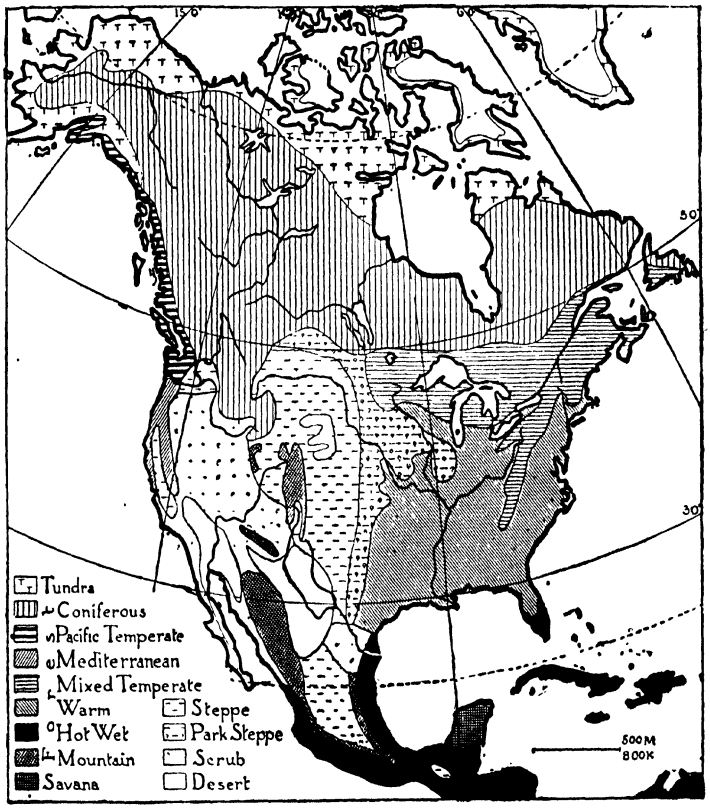


Fig. 23. Vegetation of North America.

wealth and extent of its lichen carpets; the cold desert seems to be drier here than in Europe and Asia. Though the ling heath is entirely absent from America,

other species of the heather family are numerous, and in the tundra or barrens their dwarf bushes are preponderating; among them occur evergreen *rhododendron*, *kalmia*, *ledum*, bearberries, and other bushes of a similar character, clad with lichens. The well-known bloom-mats carpeting the southern slopes of many of the hills and knolls, like islands or oases of beauty, are said to reach their best development in Alaska. The most brilliant representative of their flora, i.e. the dodecatheon primrose, has found favour in our gardens, together with a handsome willow-bush which grows along the rivers, the arctic poppy, saxifrages, gentians, &c. Further north, the tundras of the high Arctic islands become poorer and poorer in vegetation.

The lichens of the 'Great Barrens' support a fairly abundant animal population, the furs and feathers of which are sought after by Eskimos, Indians, and backwoodsmen, who repair at intervals to the trading posts of the Hudson Bay Company, the only centres of barter of these bleak regions.

The thick clouds of mosquitoes, which tenant the tundra and prove such an unmixed nuisance to man, fulfil an important rôle in the economy of the animal world, in providing an inexhaustible supply of food for the innumerable legions of migrant birds, which are attracted from parts as remote as the southernmost extremity of South America.

The Great Canadian Forest. Hudsonian Forest. In Canada the transition from cold moors to temperate conditions is very gradual, for between the actual tundra and the dense forest extends a wide belt of mixed type called the 'scattered forest'. It is remarkable that the northern limit of the regular Canadian taïga should follow the latitude of the southern limit of that of west

Siberia; the reason perhaps being the proximity of the great ice sheet which covers the highlands of Greenland, or even ultimately the climatic conditions of the circumpolar cap. The sub-arctic forest deserves indeed to be termed scattered. Over vast expanses, trees are dotted singly or in clusters, seldom in close formation; the rivers, however, are fringed on either side by regular

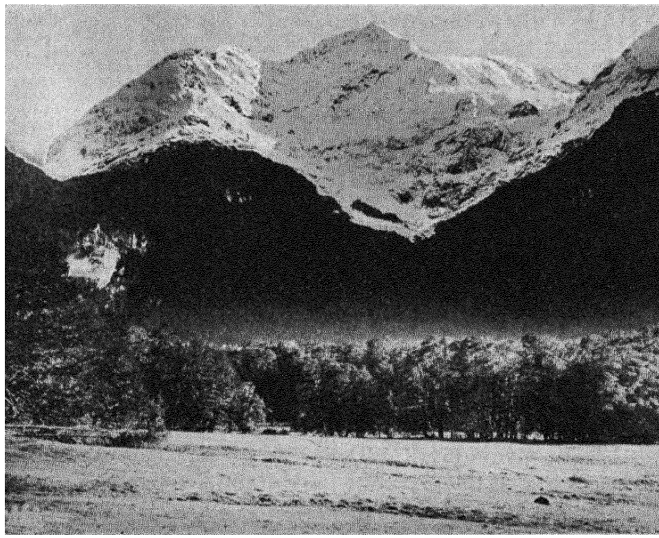


FIG 24. Spruce forest on a river flat—Canada. Pine-clad slopes and tree limit.

marginal forests which follow them, as on the Mackenzie River, almost to their mouths. The species of conifers may vary from east to west, but the general conditions, aspect, and mode of life are very similar throughout.

The soil of the north Canadian forest is all of glacial origin: sand, clay, or gravel. The irregular surface is

dotted with innumerable lakes of all sizes, is often largely marshy, and as a rule the ground is poor and cold. Moors, swamps, and meadows are freely mixed with the forests. If heath and heather are unknown, a large number of plants allied to our whortleberries, cranberries, crowberries, and bearberries, and of the same vegetative type, replace them. The sweet gale or bog-myrtle, the aromatic winter-green and the huckleberry also occur.

The Canadian forest spans the whole continent from the Pacific to the Atlantic, and is largely composed of conifers. The balsam fir, the white, black, and red spruces, the tamarack, and several species of pines are the most widespread. Leafy trees are dispersed among them, and in many instances form independent groups. Balsam poplar, aspen, paper-birch, &c., in the extreme north-west, constitute stunted, young-looking woods almost up to the tree-line. The scattered type of north Canadian forest extends over the central plateau of Alaska, between the branches of the Rocky Mountains, and almost reaches the Bering Sea. Here again the dense spruce forest is found only on the large alluvial 'flats' along the Yukon and its main tributaries.

It is difficult to over-estimate the importance of this northern advance-guard of the tree vegetation. It provides a supply of timber which, if carefully treated, may last indefinitely, as it is always renewing itself. It is also teeming with animal life. The agricultural possibilities of the region are certainly limited, but for pastoral industries of a northern type it is scarcely touched at present: timber and game are the only products which have been extensively worked so far. Life has hitherto been, as in the tundra, mostly nomadic and primitive, and fur-hunters, trappers, and lumbermen have constituted the majority of the population.

Like the tundra, this forest appears to play an important part in the economy of the animal world, being the summer resort of many migrant species from the south, and the winter refuge of many others from the far north. Its destruction might therefore mean serious trouble for vast numbers of useful birds and mammals, and involve the disappearance of many helpful animal workers. Man is only beginning to realize the cost of recklessly interfering with the established economy of nature. He has often acted in ignorance, or disregard, of the interrelations between the various sections of the plant and animal world, with serious losses in life, time, and energy for himself.

Great Lake Region, or South Canadian Forest. In the eastern half of North America, the climates change much more rapidly from north to south than in the west. The belts of vegetation are narrower and follow one another in more rapid succession; thus the forests which extend east of Winnipeg across the Great Lakes and New England are of a richer type than those of the Hudsonian region. Although more extreme than that of western Europe, and resembling that of Amuria, the climate allows a variety of species of plants to take advantage of all the modifications of soil and other conditions; hence, while this region is primarily one of conifers, it is distinguished by a large proportion of summer-green, broad-leaf forests. On sand, pine-forests predominate with the Weymouth pine, the pitch pine, and others; hemlock-spruce forms dark and damp clumps, and on marshy grounds tamarack and cedar swamps are developed. Broad-leaf, summer-green forests prefer richer and deeper soils, and either combine in pure growths or are found interspersed among the conifers. Eight species of oak, one of chestnut, six of birch, two

of beech, two of hornbeam, two of walnut, and four of hickory (allied to the walnut), are common forest trees, in addition to several kinds of maple, plane, ash, and lime. The white elm is the tallest and strongest of all Canadian trees, barring the Weymouth and other pines. This gives a wealth of timber quite unknown to western Europe. The lumber industry is well developed, perhaps too well for the proper preservation of the forests, whose existence is now seriously threatened by the axe and the paper-pulp mill, which enjoy the advantage of unlimited water-power. Another activity is fur-hunting, which has its great market centre in Montreal. The poorer soil and the more rainy climate of eastern Canada do not allow that region to compete in the growth of cereals with the more generous and sunny West. On the other hand, it favours the development of good pastures, and consequently of mixed and dairy farming, and the cultivation of fruit of a northern and temperate type. The summer-green forests in southern Canada and New England are remarkable for the extraordinary brilliancy of their autumn colours, the sugar maple being quite exceptional in that respect; and the humbler vegetation, while much richer than that of our country, is very similar in aspect and in mode of life.

Appalachian Region. South of the great coniferous belt is a vast region, the core of which is formed by the mountain system of the Appalachians. It is, or was, almost entirely forest-clad, and the type of its forests is the summer-green, broad-leaf variety, with an admixture of conifers.

An abundant rainfall all the year round, moderate winds and temperature, and a soil on the whole fairly rich, offer conditions which are admirably suited to a heavy tree-growth of the most luxuriant mild-temperate

kind. At the same time, the great diversity of the relief and of the soil permits of a large variety in the form of the forests and their components. As a rule the broad-leaf type is found on the richer soils, and largely predominates west of the Appalachians. Pine and other coniferous forests are found in greater proportion in the east and on porous sandy soils.

The circum-Appalachian region offers an admirable collection of broad-leaf and summer-green trees and shrubs requiring a relatively moist climate. Indeed, the wealth and variety of these forests almost challenge comparison with the rich flora and luxuriant vegetation of eastern Asia, in a similar climatic situation, and surpass anything seen even in south-eastern Europe. When, in past ages, the polar ice invaded the now temperate latitudes, the vegetation of eastern North America and Asia found shelter in the southern extensions of those continents. On the retreat of the ice, the new plant population of the lands thus laid bare was mostly recruited from these rich southern floras. In Europe and western Asia the earlier flora was stopped in its retreat by the Mediterranean and the mountain barriers running east to west and destroyed: the plant population which arose afterwards was mostly drawn from the east.

The catalogue of trees of the temperate type in eastern North America includes many species of oak, walnut, hickory, chestnut, birch, alder, hazel-nut, hornbeam, willow, poplar, elm, magnolia, tulip-tree, maclura, laurel, sassafras, plane, maple, ash, robinia (our common acacia), horse-chestnut, and allied trees. Conifers are represented chiefly by pines. Among the countless shrubs of the undergrowth, numerous species of rhododendron and magnolia are the most remarkable, with kalmia, and several shrubs allied to it and to

the rhododendron. Our common Virginia creeper has its true home there, and the autumnal beauty of its foliage may serve to give an idea of the gorgeous colours of autumn in the Great Lake district.

This vast region is so varied that it naturally falls into large divisions or provinces, each with a character and a plant-world of its own. The wide terrace which extends at the rear of the lower coastal plain up to the foothills of the central Appalachians shows a transition between the lake region and the more luxuriant south, as far as vegetation is concerned. It possesses, amid the deciduous forests, a large admixture of patches and clumps of conifers, the Weymouth pine and the red spruce being the chief of these. On the whole, the vegetation of this belt is similar to that of central Europe.

On the seaward side, this terrace is followed east of the line New York-Washington by a lower and much indented coastal shelf, whose dry, sandy-gravelly soil can only support pine-forests and a meagre flora. These constitute the so-called 'Pine-Barrens'.

The Appalachian range, in its central and southern portions, was once almost entirely timber-clad, and still retains magnificent vestiges of its former wealth. In the central portion the forests are mixed: among other conifers, the Weymouth pine attains there heights of 100 to 150 feet. Magnolias, rhododendrons, kalmias, and other shrubs form a dense and beautiful undergrowth, sometimes overtopped by the tall pines, sometimes by the deciduous trees. Above the limits of the broad-leaf forests, the black spruce and Fraser fir predominate. The higher ridges and peaks are covered with subalpine heaths, composed of tall scrub and grassy glades.

Proceeding down the valleys of the southern Appalachians in a south-eastern direction, a regular series of belts parallel to the mountains and the coast is crossed: the sandy and gravelly foot-hills, a broad terrace resting on hard rock, and the alluvial coast plain or Eastern Valley. In each, the temperature becomes milder and more regular, the rainfall less abundant, and the soil more fertile. Correspondingly the ratio of conifers decreases and that of the broad-leaf evergreens increases, while the dominant type of vegetation remains the leaf-shedding forest, with a greater variety of species but, perhaps, a less luxuriant growth than in the mountains. The sequence of belts down to the sea-coast is broken by the interposition of a long strip of pine forest which runs parallel to the coast-line and round the extremity of the Appalachians, across the valley of the Mississippi, far into Texas. This pine belt exactly coincides with, and is due to, the development of rolling downs, sandy and porous. Beyond it commence the low mud flats of the shore intersected with marshes and lagoons, where the evergreen vegetation of the south is in evidence, and the transition to the vegetation of Florida and the southern states is so gradual as to be imperceptible.

The Atlantic lowlands, and—to a large extent also—the mountains, have been cleared of their timber; the former, to make room for cultivation and industry, the latter simply to obtain the wood. The consequences attending the destruction of the mountain-forests have been, as usual, very serious: destructive floods, the ruin of the slopes, &c.: and protective measures have had to be resorted to. In the lowlands, agriculture, especially the growing of cereals, has no longer the importance it used to possess when the West was yet uncultivated.

Mixed farming for local needs is still practised, but the interest of this region now lies in other directions.

South of Washington, in the rich Eastern Valley, the country is less industrialized; though cultivated fields of a southern type, with tobacco, cotton, and the fruits of warmer climates, have superseded the luxuriant summer-green forests. Free from the competition of the wheat- and maize-growing West, agriculture plays a more important part than in the north. The sandy pine-belt yields only lumber and wood products.

West of the Appalachians. The country west of the Appalachians is formed by the Alleghany and Cumberland plateaus, continued westward by the lower and undulating plateaus of Ohio, Kentucky, and Tennessee. Here the climate is not so mild as in the east; winters are colder, summers warmer, and the rain does not fall so regularly throughout the year. In spite of such minor differences, comparable with those which exist between the rainy belt of western Europe and the more extreme central portion, the climate is primarily favourable to the growth of the so-called 'hardwood' or broad-leaf, non-coniferous forest type. The soil is fertile, and the whole country was a fairly continuous forest prior to the dense settlement of man.

Rivers are screened by dark and marshy woods, and luxuriant meadows cover the heavier bottom-lands. On higher ground rise forests comprising many kinds of oak, hickory, and a rich variety of leaf-shedding trees: the ridges of the hills naturally bear lighter forests. The vegetation, on the whole, is very much like, but not so luxuriant and diversified as, that across the Appalachians; it constitutes really a step towards the drier conditions of the west. Here is the true home of the common 'acacia' (more accurately *robinia*, or false

acacia) and other similar leguminous trees, such as *gleditschia* and *gymnocladus*.

On the dry limestone heights of Tennessee there are forests of tall junipers, producing that excellent red wood which serves for pencils. The so-called 'cedar-glades' continue down to Alabama, and forests of this tree are also found in Florida. Gradually, however, as one goes south, the number of evergreen trees and shrubs increases. Mixed forests of summer-green and evergreen components now mark a step towards the sub-tropical vegetation of the southernmost States, and evergreen magnolias become abundant.

The low and broad alluvial plain of the Mississippi valley, across which the mighty river has thrown vast swamps, with a dense network of sluggish, meandering arms called 'bayous', is particularly well irrigated and fertile. It is difficult to distinguish the forests which cover it either from the sub-tropical rain-forests or from the summer-green type of the plateaus; the Mississippi valley offers all transitions from one to the other with a tendency towards the luxuriance of the south. A long way up the river, the bayou country favours the extension of the rain-forests into the cooler regions. Beyond the plain of the Mississippi, according with a gradual decrease of rainfall, the higher plains of Arkansas and eastern Texas possess lighter and poorer woodlands, which herald the approach of the western prairies.

The vast region which extends from the Appalachians to the prairies is one of the largest granaries of the world. Agriculture, in spite of the intrusion of other industries, continues to play an important part in the life of the country; owing to the wealth of water- and rail-ways, it is afforded an almost unlimited scope. Wheat in the north, maize south of the forty-second

parallel, are grown in enormous quantities, and tobacco still remains a staple product of Kentucky and Tennessee. South of the thirty-seventh parallel, conditions are suitable for the growth of cotton, which, from Texas to the Atlantic, becomes the chief crop; indeed, the southern States are the most important cotton producers in the world, for it requires a well-watered soil, though otherwise adapted to somewhat dry climatic conditions. Sugar-cane has long been grown in the southern States, but there is a tendency towards limiting it to the warmer climate of the West Indies, Mexico, and inter-tropical regions. This rich agricultural centre of the States has long been the mainstay of the wealth of the country, and must remain so, in spite of the invasion of industry. Its importance is so far-reaching that the condition of its crops is anxiously watched year by year in other countries which depend on it for the raw materials of many of their manufactures.

For a long time, also, the American forests of those parts have supplied the world with valuable timber, but on account both of their rapid disappearance and of the growing consumption at home, they are no longer able to do so to the same extent as formerly.

Southern States. The Atlantic shelf up to Cape Hatteras, and the northern shores of the Mexican Sea, enjoy a warm and rainy climate, whose expression in the plant-world is the evergreen rain-forest of a temperate type; but the variety of conditions of the soil induces a corresponding diversity in the flora and curtails the area belonging to the rain-forest proper. On the northern shores of the Gulf of Mexico, nearest to the beach, comes a strip of sandy downs tenanted by swamp-pines and sabal palmettos. Behind this curtain

extends a belt of swamps and moorland, frequently flooded, and covered with reeds and sedges. It is the abode of the tall swamp- or bald-cypresses which lose their needles in winter. The terraces and hummocks between and beyond the marshes are clad with evergreen temperate forests, in which the incense-tree or *liquidambar*, the evergreen or virginia oak, predominate, often draped entirely with the lichen-like epiphyte *tillandsia*. Evergreen magnolias, rhododendrons and other shrubs of the same family are in evidence in the undergrowth, where tall cane thickets give a touch of the Tropics. Mixed forests of pines and oaks follow on the higher and rolling slopes which lead up to the tableland of limestone, which unfolds a park landscape of prairies, scrub, and forests of a hard-leaf evergreen character and where the 'cedar-glades' of Tennessee recur. Further inland the plateau is interrupted by the great pine-belt which extends over sands and sandy loams far into Carolina. This vegetation is carried also into Texas, while the belt of coast-swamps nearly reaches the delta of the Rio Grande. Where the nature of the ground allows it, the southern States have a prosperous agriculture of a sub-tropical type, cotton, sugar-cane, and tobacco being the staple crops, worked by means of negro labour.

Texas. Westward from the Gulf of Mexico, beyond the dense cane- and cypress-swamps and damp coast-meadows, there is a gradual ascent to a plateau rising by successive broad terraces to a height of about 4,000 feet. The lower terraces are naturally much eroded and form a belt of rolling land, which is mainly composed of light, sandy loams and clays. This region has a distinct season of heavy rains of about ten weeks' duration, the rest of the year being nearly dry.

The landscape is that of a very open park dotted with light trees, such as the acacia-like mesquite, walnuts, and others, either single or in sparse groves, resembling open oak-copses. The grass grows taller than that of the more northern prairies, and is also more diversified. Limestone hills, naturally drier, are covered with a scrub of thorny shrubs, which shed their leaves during the period of drought. The mesquite and allied species, various kinds of acacias and other *Leguminosae*, with a light foliage and stunted growth, compose this scrub or 'chaparral', which farther west becomes such a special feature of the landscape.

At last the great **Staked Plain,** or **Llano Estacado,** is reached. It is an almost level and typically semi-arid short grass country, with a fine loose soil. Here new types from the hot and dry regions give a peculiar stamp to the vegetation: they are the well-known yuccas, agaves, cacti, cerei, opuntias, and other fleshy or 'succulent' plants, many of which yield fibres. These plains are rich in bulbs and tubers, and most plants have deep, swollen roots. Extensive salt clay tracts are strewn over the surface of the Llano, all marked by strands, and open colonies of the usual succulent salt-bushes.

Towards the Rio Grande, the character of the vegetation becomes still drier. Grass grows scarce, and is only represented by dense bunches of stiff straw. On the naked, stony soil of the rolling downs a scattered brush appears, almost entirely composed of the prickly bunches of the yuccas, sotol, agaves, &c., studded with giant cerei and tree opuntias. This is the margin of the desert of New Mexico and Arizona, which extends beyond the Rio Grande over into Mexico. The valley of the latter river, now contracting into a cañon clad with scrub, now expanding into a rich alluvial and agricultural plain,

now thrown into broken ground, much eroded, with ruined tables or 'mesas' left standing, offers a large variety of landscape. The flat tops of the dry mesas have but a poor, semi-desert brush of leafless shrubs, cacti, bushy composites, and scanty bunch-grass.

The Llano Estacado and the transition zone of Texas can be largely used for cattle-breeding; part of Texas is indeed a country of ranches, where cattle are left to roam and find their own food over vast areas. Along the rivers one comes across agricultural strips, but in the arid sotol districts little can be done apart from the slow cultivation of fibre-plants. Cotton is naturally confined to alluvial tracts where irrigation is possible; yet these tracts cover a sufficient surface to constitute one of the main assets of Texas and north-east Mexico. The water-melon and other fruits are also cultivated extensively.

The Grass Belt. Broadly speaking, west of the 100° meridian, up to the long Rocky chains, stretches a vast region with a type of vegetation different from that already described; it consists of flat or rolling plains, rising westward to the foot of the mountains. The most important feature of its climate is dryness, due to its central position in the great body of land and its consequent distance from the sources of moisture, the seas. The rainfall hardly rises above a yearly average of 20 inches, and is most abundant at the growing season. Summers are scorching and winters very hard in the north and centre.

The conditions of the vegetation throughout the great grass-belt are very uniform. Over large territories the endless table-like plains stretch, only furrowed by sunk and invisible valleys. 'No trees, no shrubs, no tall herbs'; but dull green close swards of buffalo-grass or

grama-grass, two or three inches high, among which dwarf herbs are scattered. These grasses are very low and dry-looking, with narrow, rolled-in, wire-like leaves; by means of their runners, they make a dense, velvety carpet upon the thick felt mat of their tangled roots. The power of the soil to retain moisture naturally exercises a great influence where water is so scarce, and the composition of the sward varies accordingly. Buffalo-grass is prominent, often exclusively present, on clay or sandy grounds, whilst grama-grass and prairie grass are more abundant on loams.

Now and then the flat plain heaves up into rolling wolds, or even into undulations. The ridges then preserve the dry steppe aspect, but the troughs assume an appearance more or less approaching that of our pastures. On porous soils, prickly plants, small species of opuntias or prickly pears, and cerei are in evidence. Towards the eastern margins, plants grow taller, flowers are more abundant, and the prairie gradually passes to the meadows of the east. On the poorest and most permeable territories, like those on the north of the Platte River, the prairie approximates to the true desert and forms what is known as the 'Bad-Lands': arid tracts, hilly, creviced, and broken, on the loose soil of which frequently 'not a speck of green is visible'. Where vegetation appears, it is composed now of dwarf cacti and prickly pears, now of small, fleshy-leaved, thorny bushes one or two feet high; further on of patches of woolly, greyish *eurotia* (*Compositae*). Another variety of the prairie landscape is found on the sand-hills which extend in a broken belt over parts of Dakota, Nebraska, Kansas, and Texas: these rolling downs are covered with a sparse crop of bunch-grasses. As the great plains slowly rise to meet the foot-hills of the Rocky Mountains they undulate



FIG. 25. The Canadian Prairie.

more and more heavily. The grama now becomes the typical grass; wormwood bushes mingle with it and finally replace it to form a pure 'sage-brush' on the foot-hills.

The sunk valleys which break the flat or rolling surface of the prairies provide the eastern forest vegetation with paths along which it reaches to the heart of the grass-country. Fringing woods accompany the rivers a very long way up, composed of the usual kinds of broad-leaf deciduous trees: oaks, elms, lime-trees, walnuts, and hickories, with the robinia-like trees *gymnocladus*, *gleditschia*, and a few others.

Towards Texas the vegetation is gradually enriched by the appearance of southern plants, which already impress upon the Llano Estacado a stamp quite different from that of the central and northern prairies; indeed, it belongs to a distinct region. On the east the great treeless plains are not sharply defined from the forest lands of the Mississippi; it is only gradually that the forests of the central region become poorer, thinner, and more stunted. Islands of trees, then of bushes, lost amid the sea of grass, give the landscape the features of a park, and constitute a belt of so-called 'bush prairie' round the treeless area. The park prairie extends into Iowa, approaching the Great Lakes, as a sort of bay into the forest region. The banks of streams, the moister hollows, the slopes and foots of the rises, and other favourable localities still retain clumps and patches of deciduous trees throughout this intermediate belt. The most extensive of these tree-islands is thrown athwart the middle course of the Red, Canadian, and Arkansas rivers; it is known as the 'Cross Timbers', and covers most of the Indian territory.

The Great Prairie is the replica of the Great Russian

and Asiatic steppes, and is due to similar causes. Until recently its substantial buffalo and grama grasses supported large herds of bison and numerous other animals. These are now replaced by half-domesticated cattle, tended by mounted herdsmen known as cow-boys. If, however, the prairies are thus almost exclusively pastoral, irrigation has been the means of rendering available part of their naturally fertile soil for agricultural purposes, as the demand for cereals has increased. This is especially the case for the generous lands of Canada bordering on the Great Northern forest, south and west of Winnipeg. There is a striking parallel between the lines of modern development of the great temperate grass areas of the world: the Russian steppe, the Argentine pampa, the African veldt, and the American prairie: they are becoming the main granaries of the world. The American prairie, however, enjoys the superiority of greater water-power and easier communications.

The Western Mountains. The winds from the Pacific are the mainsprings of life in western North America. On their moisture and distribution in relation to the features of the relief depend the manifold changes in the vegetation. Moisture decreases from the coast to the inland mountains, and, on the whole, also from north to south. The windward are moister than the leeward slopes; again, low-lying areas are drier than the ridges, and moisture increases with altitude up to a belt of greatest rainfall, above which it diminishes rapidly. The plains lying between the mountain ranges are naturally arid as compared with the neighbouring slopes. For all these reasons, western North America may be described broadly as a succession of three parallel wooded chains separated by arid troughs and plateaus.

Of the three main ranges, the Coast and the Cascade chains may be grouped together as representing a moister system; while the Rocky Mountains, separated from these by a series of broad plateaus, form a much drier eastern wing. Only at one point in the Columbia-Frazer district, thanks to the gap in the western barrier



FIG. 26. The prairie passing into a brush of summer-green bushes and small birches—Wheat zone, Western Canada.

through which the river Frazer flows, does the inland chain share some of the moisture and luxuriance of the coast-ranges.

The forests of Pacific North America are almost exclusively composed of conifers. Why this should be so is not satisfactorily explained yet. It is quite certain that many of the varied climates and soils, as they

stand at the present time, are eminently suitable for at least an abundant admixture of broad-leaf summer-green forests, and that similar circumstances, at the other end of South America, in southern Chile, in New Zealand, and in Europe, favour the development of such broad-leaf trees. It is therefore likely that the cause of the exclusive predominance of conifers here will be found mainly in the geological history of the country.

The northern half of the coast-ranges enjoys a rather moist and temperate climate; even the seaward slopes of the southern Alaskan range have a comparatively mild winter. Hence the coniferous forests in these regions, south to latitude 43°, display a luxuriance unsurpassed in any part of the world. The predominant forms, spruces, firs, douglasias, tsugas, possess heavy crowns; the lighter pine form is subordinate. Towards the mouths of the Columbia and Frazer these forests reach their maximum of wealth and density on the seaward slopes: heavy crops of gigantic trees, and a ground encumbered with a tangle of dead wood, padded with thick layers of mould, and carpeted with mosses and ferns.

Though the variety of tree-forms decreases as one goes towards Alaska, the seaward slopes of the Pacific coast mountains continue to enjoy a mild and humid climate up to Cook's Inlet. They display, in contrast to the central Alaskan plateau and the Rocky Mountain chain on the north of it, the same luxuriant type of hemlock-spruce and cedar forests; South Alaska indeed presents the appearance of a beautiful mountain park pleasantly diversified by rich, flowery meadows. Above 1,200 feet the park landscape changes to sub-alpine pastures dotted with groves of alders and willows; and a treeless belt of alpine grasses reaches to the snow-

line. In point of structure and vegetation the Columbian-Alaskan coast, with its ever-moist climate, strikingly recalls that of southern Chile and, nearer to us, of Norway.

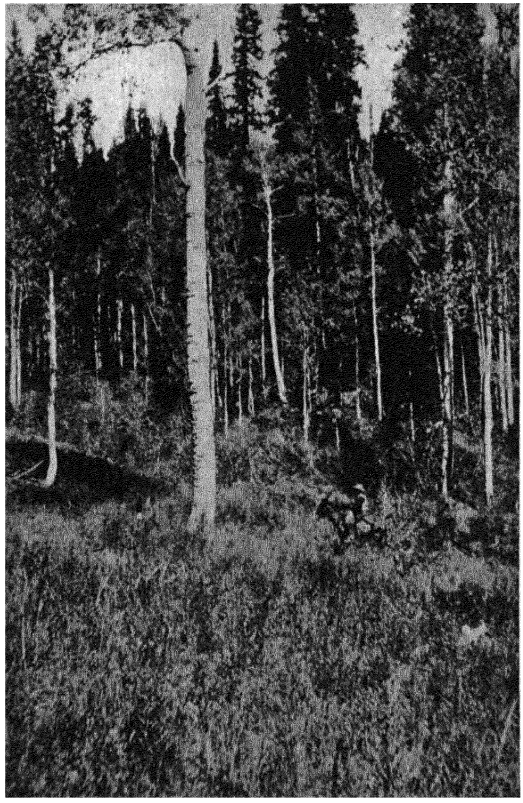


FIG. 27. Pine forest bordering meadow. High plateau in the Rocky Mountains.

These forests abound in large animals, among which wild sheep are to be found. Naturally the chief industries are concerned with timber; but the rivers,

teeming with fish, are another source of wealth. In short, this northern Pacific coast affords a picture of what the west coasts of Scotland and Ireland were like previous to their complete ruin by man, with this difference, that the species of trees in our countries were not so varied. The numerous islands are similarly clothed with conifers.

The eastern or landward slopes are decidedly drier. In Alaska the timber-growth on the northern slopes of the coast-range is much more scattered and loose, and belongs to the 'scattering' belt of the North Canadian forest.

Further south, the difference between the sea- and land-slopes is marked by the abundance of the pine-type on the inland side, and the thinner, shorter, and poorer forest-growth. An increasingly meagre and smaller kind of forest is carried along the coast-range proper down to San Francisco: the Californian portion which follows on the south is no longer timbered; thin woodland patches of some extent can only be seen occasionally. The predominant vegetation is now the 'chaparral' or scrub; yet in northern California the Californian red-wood, with the Monterey cypress, form stately forests with a dense undergrowth of hard-leaf evergreens.

Behind the coast-range, and still able, thanks to their superior elevation, to condense a fair amount of moisture from the sea-winds, the southern Cascades offer in a lighter form the same vegetation, in which douglasias, tsugas, and spruces are conspicuous. The sugar-pine attains here the largest proportions, and several kinds of silver-firs are found on the upper slopes. The eastern slopes are again poorer, for the forest growth becomes patchy and scattered, with hardly any cover on the

naked ground. Pines now preponderate, and among them the yellow pine, the most valuable and widespread timber of the west. Here, again, the southern portions are notably drier and more barren than the northern.

South of Mount Shasta moisture is still scantier, and, henceforth, in the Sierra Nevada, the westward slopes are invaded by a number of species which heretofore



FIG. 23. View in the Rocky Mountains, showing pines and Douglas firs.

were confined to the eastern side. The high forest, which rises above a belt of chaparral, consists of much the same trees as that of the Cascades, in addition to southern species. The chief ornament of the southern Sierra Nevada is the broken patchy belt of Big-Trees, of which a few thousands are still left, now protected against destruction.

The forests on the Pacific side of the Rocky Mountains afford but a ragged mantle: in the Alaskan region the thin groves of spruce are limited to the secluded southern valleys: in British Columbia the stunted form of the Murray pine predominates in thin woodlands; but on the upper reaches of the Columbia River the moist winds penetrate farther inland, and with them, some of the western types, the Douglas and the yellow pine among them, extend to the Pacific slopes of the Rockies.

Further south the mountains assume a decidedly park-like appearance, with forests in patches, or large copses on the naked slopes. They are clear and open, without undergrowth, and confine themselves more and more to the cañons and the higher altitudes. Towards the head-waters of the Colorado River, and south of them, sufficient moisture from clouds, rains and snow is restricted to a belt of 2,000 or 3,000 feet at an elevation of 9,000 to 10,000 feet, giving thin forests on the upper slopes which, with the pastures of the lofty plateaus, form here a veritable park region of some luxuriance, far above the adjacent arid lands.

Probably because it remains too low, the Wasatch branch of the eastern mountain system is still more barren, and displays only a stunted and loose type of woodland on its rocky slopes. The close forests of the north, favoured not so much by rainfall as by the layers of snow which soak the ground in winter, do not recur until the edge of the Colorado plateau, the higher mesas such as the Mogollon, or the higher peaks such as the San Francisco, are reached. Here, above a belt of dwarf-pine and juniper or piñon rises, from 8,500 to 12,000 feet, the high forest which is arranged, in order of increasing altitudes and precipitations, into the three zones of pine, fir, and spruce.

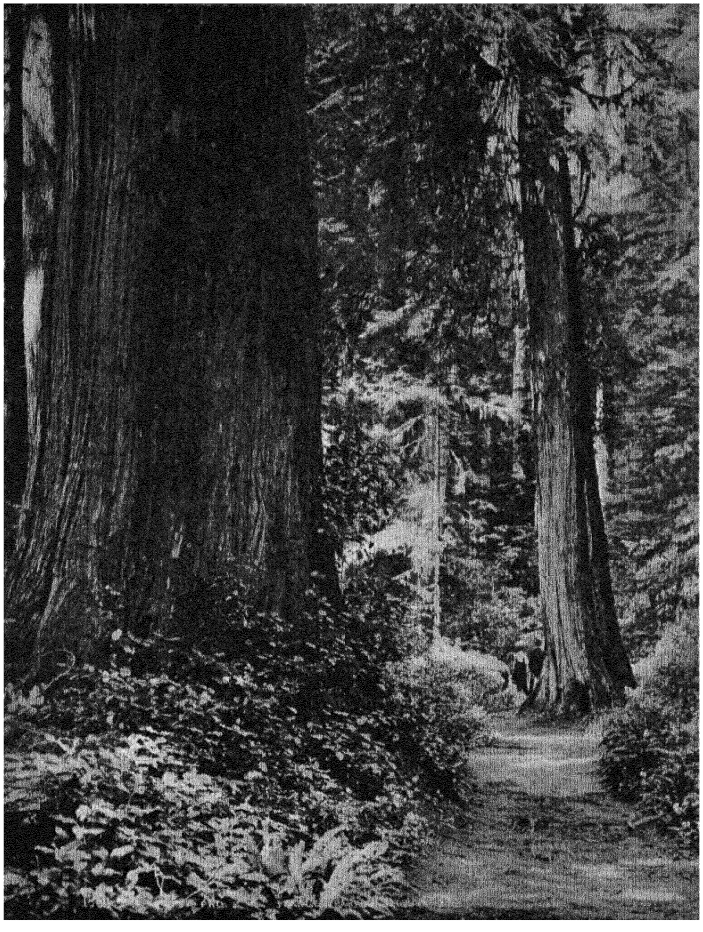


FIG. 29. Big trees in the Coastal Forests of British Columbia. The size of the people gives some idea of the gigantic size of the trees.

The western ranges have furnished, for a long time, an abundant supply of timber, the yellow pine and the Douglas or red fir being considered the most valuable. The Canadian portion has been little touched so far, except by forest fires; but in the United States the axe and the fires have wrought immense harm to the forests, and entire districts have been laid bare. This is

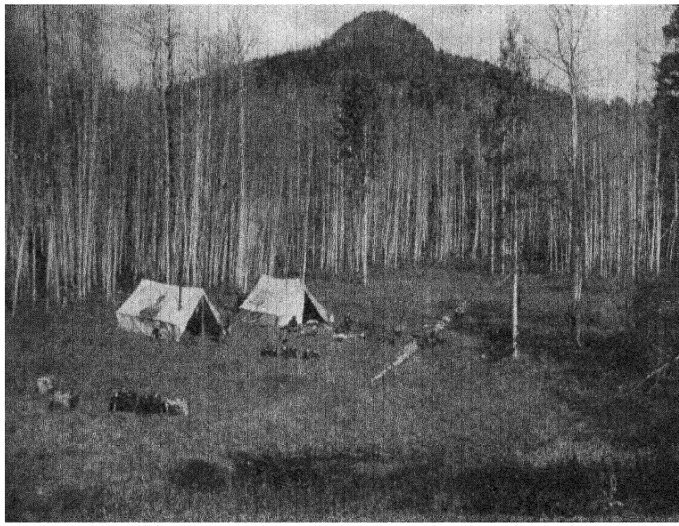


FIG. 30. Aspen forest in Colorado.

the more serious as one goes further south, where drought does not allow the vegetation to recover so rapidly as in the moister north, and whole chains have been denuded down almost to the rock, with disastrous results. In other parts, especially in California, where mines have exhausted the surrounding districts, the useless chaparral-scrub has extended considerably over former timber areas. Now, however, a large number of

forest reserves have been created with a view not only to protecting the mountains themselves and the adjacent lowlands, but to preventing the further extension of reckless and harmful lumbering.

Intermont Plateaus of the Pacific. Between the Pacific coast-systems of mountains and the Rocky Chain there stretches a succession of broad plateaus of varying height and character. All of these, screened from the Pacific winds by the mountain barriers, are naturally drier than the adjacent slopes. North of the Columbia River they bear a park-like aspect, south of it they are treeless and arid. The Yukon plateau, the northernmost, has that scattered tree-growth which is characteristic of the northern belt of the Canadian forest. The meagre grass-land, varied by meadows and swamps, is studded, over large areas, with isolated spruce trees. Connected and denser forests cover only the margins of the Yukon and its main tributaries and their alluvial flats. With the aspen or cottonwood, the spruce penetrates into the valleys of the mountain-chains on both sides of the plain. Lying at a greater elevation and fissured by deep valleys, the Columbian plateau presents flat grassy tops of a sub-alpine type, dotted, like the Rocky margin, with small Murray pines. The deep cañons alone are well wooded, and enable the coast-forest to penetrate far inland.

The Frazer-Columbia district has been already mentioned as being happily situated for favouring the inroads of the western vegetation. On the south it is bordered by a hilly belt of broad-leaf, winter-bare woodland, consisting mostly of aspen, and dying out towards the Columbia River. The Columbia plateau affords good grazing-grounds, while the forests of its valleys are well stocked with timber: game and fish are plentiful, and the

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salmon-packing industry is very active. The lower Frazer and Columbia valleys are extensively cultivated for wheat.

East of the Cascades, and closed in on all sides by mountains, the plain of the lower Columbia River, situated at a low level, is treeless, smooth, and grassy, and recalls the Great Prairies: it is well irrigated by a number of large rivers, and occupies the fertile bed of a former lake. Such conditions offer quite exceptional opportunities for agriculture, and especially for wheat-growing. In easy communication with the Pacific ports, the Columbia plain is one of the most natural and best-defined wheat areas that can be found anywhere. All around its margins the foot-slopes of the mountains are covered with woodlands of cotton-wood and other winter-bare trees, while in the rear rise the pine-clad upper hills.

Beyond the Blue Mountains, which limit this plain on the south, is a much more arid region in southern Oregon and Idaho, and here begins the great semi-desert, which stretches far into Mexico, and from the Sierra Nevada to the Rocky chain. Its general level—above 3,000 feet—and its rainlessness render the climate extreme and arid. The northern part is largely covered with lava sheets, which have dammed up a number of lakes and thus caused marshes. At the foot of the Cascades lies a park landscape of meadows and wet moors, girdled with forests of aspen, above which rise pine-clad slopes, while the broken basalt tables remain barren. Farther east, dreary plains follow with thin brushes of 'sage', a name which includes several kinds of bushy, hoary, and stunted artemisias or wormwood, and similar plants, with small, grey, woolly leaves. The sage-brush constitutes the background of the vegetation

over the whole tract down to the Mohave and Gila deserts.

The Great Basin of Nevada differs in aspect from that of Oregon-Idaho, for countless short, parallel, rocky ridges and bluffs, all running in a general north-south direction, arise abruptly from its floor. Though rains be scarce, the waters of the casual showers collect in the troughs

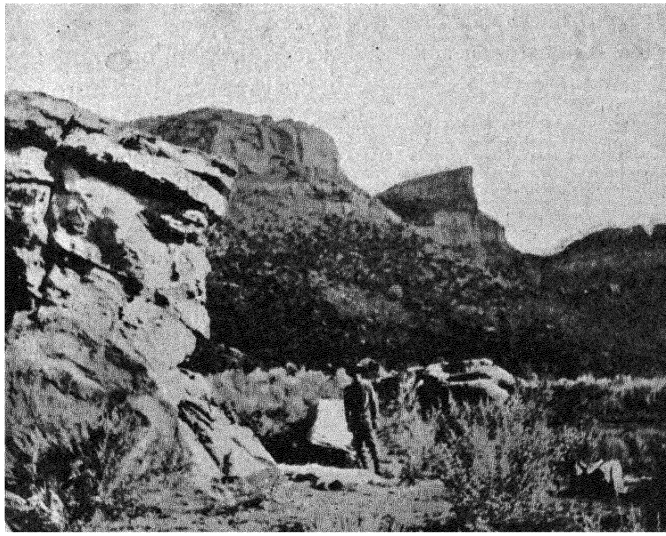


FIG. 31. Sage-brush. Colorado.

of the irregular surface, which they line with clay and convert into evaporating pans, many of them covered with layers of alkaline efflorescence and absolutely barren: successive belts of succulent salt-bushes, rushes, grasses, and shrubs surround them. Outside the saline flats, and covering alike the valley plains, the gentle inclines of the mesas, the rounded foot-hills, and the lower mountain slopes, the very uniform vegetation consists almost

exclusively of the sage-brush, growing about three feet high, in a loose formation which is never an obstacle to the rider. With it may occur, according to the situation, a few similar bushes, with whitish, small, strong-scented leaves. This permanent vegetation is brightened, after showers, by the sudden outburst of a flora of dwarf annuals which disappears as quickly as it comes. Other biennial and perennial herbs likewise wither and disappear from the surface in July.

The steep western slopes of the Wasatch Mountains are destitute of trees, dry and naked. From this chain to the Sierra Nevada, on the rocky slopes of all the ranges, is found, at an elevation of 5,000 to 7,000 feet, a thin sprinkling of western junipers and stunted, single-leaved pines, some ten to fifteen feet in height, and of low, compact habit. Only on the principal ranges, above 6,000 feet, can the mountain mahogany be met, clinging to the rocky ledges and on the dry inclines. The cañons are lined with a ragged brush of pines, firs, and junipers. Where the ground water accumulates, however, the desert is graced by delightful oases, marked by the characteristic aspen, willow, poplar, and other leaf-shedding trees of a northern type.

As will be seen, the vegetation of the Great Basin corresponds closely with that of the Algerian plateau in north-west Africa; it may also be compared with a large portion of the plateau of Asia Minor.

The Colorado plateau included between the Wasatch and the Rocky chains extends south to the line of the Mogollon Mountains, when it sinks abruptly along a much broken bluff down to the sweltering desert of Gila. It is a high tableland, cut up by deep and precipitous cañons into large flat-topped blocks or mesas, arid and treeless, with a scanty plant-mantle of bunch-grass and grama-

grass, interspersed with colonies of low cacti. The cañons vary greatly as regards vegetation; some of them have naked walls with nothing but crooked pines sticking

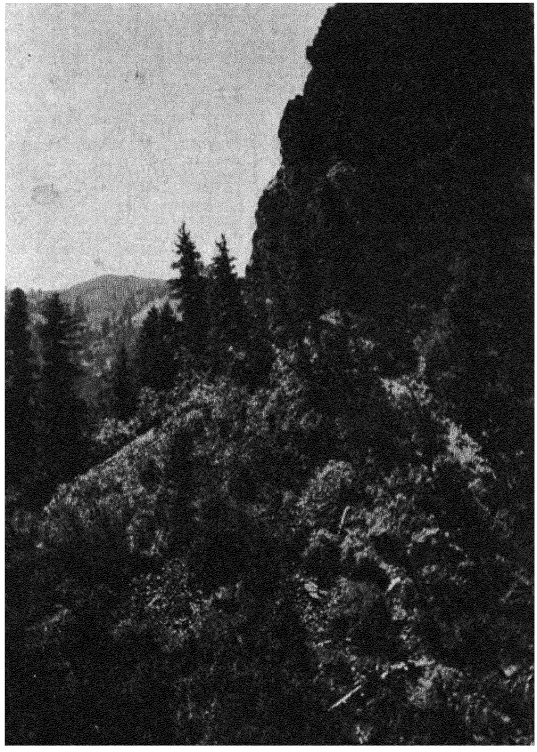


FIG. 32. A typical timbered cañon in the Colorado Region.

occasionally out of crevices; others are clothed with luxuriant and regular pine-forests, including the yellow pine and the douglas or red fir.

A few valleys, like those of the Rio Grande and San-

Luis. are broad enough to permit of the development of rolling, sandy, or gravelly wastes at the bottom, when artemisias and other sage-brush plants regularly recur. Agriculture is not altogether excluded from those tracts, if means be taken of preventing the surface evaporation of the soil, and of thoroughly utilizing the ground moisture: on these principles is based the system called 'dry farming' or dry-land farming, which has succeeded in wresting good maize crops out of what looked like mere sand wastes. Above the general level of the plateau rise a few mountain ranges which are able to catch the rain and the snow, and consequently are as a rule well wooded. Some of them unexpectedly reveal delightful Alpine corners with prosperous forests of conifers and aspen, luxuriant meadows, marshes, and pastures, in the midst of the general aridity.

California. If the Great Basin, in respect of its vegetation, recalls the Algerian plateau, California gives a striking replica of the Mediterranean landscape, and more especially of the Algerian tell. The Californian valley extends from the coast-range to the Sierra Nevada in continuation of the trough that separates the mainland of British Columbia from the coast islands, and is, in turn, continued southward as the Gulf of California. Lying in a hollow, and deprived of most of the moisture of the Pacific winds, it enjoys a moderate rainfall during the winter, and a pleasant warm temperate climate. The floor of the valley, which is, in places, naturally well watered, displays a park landscape in which the hard-leaf and evergreen vegetation is prominent. Dry grass steppes claim a large portion of its area, but evergreen oaks with small leathery leaves, the Californian laurel, cypresses, and a large number of evergreen shrubs, correspond to the similar plants of the Mediterranean.

This parallel is still further exemplified in the 'chaparral', which is an exact replica of the European maquis, as far as the growth and mode of life of the plants are concerned, though the species may differ. The chaparral, with its impenetrable thickets of evergreen shrubs with leathery, prickly leaves, and thorny bushes, dwarf oaks, and others, is a feature of California: it extends along the sea-coast in a belt on the lower slopes of the ranges on either side of the valley, and is characteristic of the foot-hills of almost all the ranges in Arizona and New Mexico. It is also a predominant and ever-present feature in north-western Mexico and lower California, and much of it is doubtless due to the destruction of forests. The similarity between the two warm temperate regions of Europe and America is continued in the forests of conifers, the composition, habit, and undergrowth of which correspond, point for point, with similar forests of the Mediterranean.

Quite naturally, California has borrowed its agriculture from the Old World: olive- and vineyards, orchards of peach-, orange-, and lemon-trees; mulberry-trees for silk-worms, &c., have been adopted and, by means of new cultural methods, developed rapidly in the hope of soon equalling the European produce. Those strenuous efforts have been attended already with some measure of success. The harder kinds of wheat are also grown extensively, along with maize and lucerne or alfalfa, on the tracts of dry grass, where ground water is available.

The American Deserts. The Great Basin gradually passes, on the south, to the Mohave desert which extends beyond the Colorado, at the foot of the Arizona plateau, under the name of the Gila desert: a complete drought, a fierce heat, and an extremely dry and clear atmosphere are the features of this region. Compared with the

African and Asiatic deserts, the American desert is remarkable for the extraordinary development of those fleshy, thorny, leafless, or apparently leafless, plants called succulents. Nowhere in the world is there such a combination of weird, ungainly, menacing shapes: giant candelabra-cerei of most diverse varieties, mamillarias, opuntias, yuccas, agaves, dasilyrions, nolinas, &c. Hardly less strange are the leafless brushes of the creosote-bush (*larrea*) and the ocotillo (*fouquiera*) and the formidable spines of several thorn-bushes belonging to the acacia and mimosa type. A good many plants with strong underground stems only show themselves after the occasional showers. This water-storing vegetation provides the rare native or traveller with a beverage which, such as it is, is often most necessary.

Proceeding eastward, one has to cross a mountainous tract which is the northern spur of the western Sierra Madre: here the prickly chaparral resumes a prominent position in the landscape, and pine forests crown the summits and upper slopes. Not a few valleys collect the underground waters and develop good pastures, while some harbour delightful oases.

Being destitute of large mammals, the American desert does not even afford a good hunting-ground, and the population is now dispersed in little communities along the eastern margin and the few large rivers. Yet, at one time, in more than one cañon, and on the outskirts of the plain, the Papagos Indians were able to evolve a fairly advanced system of agriculture based on extensive works of irrigation. These works reveal the past existence of a highly organized agricultural community, of a centre of culture which has possibly disappeared in the ever present struggles between the nomads and the house builders.

Lower California and Northern Sonora. Lower California is the southern spur of the coast-range and possibly of the Sierra Nevada, while the plain of Sonora continues the Colorado desert to the south.

In point of aridity, the northern portion of the

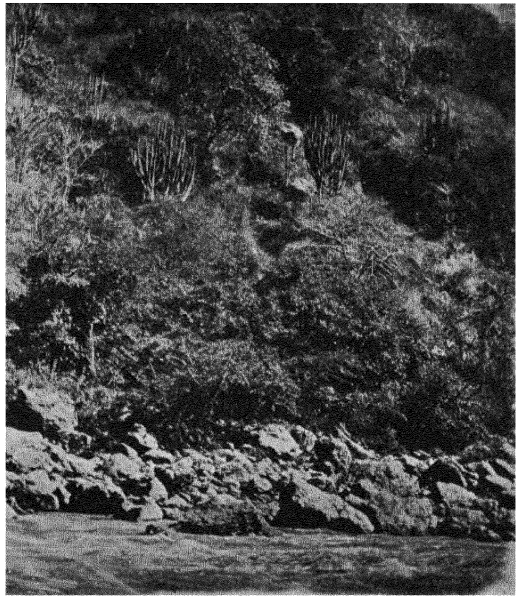


FIG. 33. Dry Cereus scrub on steep slopes of a gorge—Mexico.

peninsula and of the Sonoran coastal shelf compete with the Mohave-Gila region; it is another land of thirst. The Pacific coast, barren and torrid, shelters a few strips of scattered chaparral in the troughs of the valleys, and occasionally tolerates short fringes of mangrove-bushes on the tidal marshes; everywhere the

climatic aridity is enhanced by the porous nature of the lava which covers most of the surface of the peninsula: but a material change intervenes towards the point of lower California, due to a combination of granite soil and irregular monsoon rains. In favourable places, wellnigh all tropical fruits, mango, papaw, banana, &c., can be successfully grown; and on the longitudinal ridges of the peninsula are scattered coniferous woods. This region is practically uninhabited.

The western coastal shelf of the mainland of Mexico becomes increasingly fertile towards the south. Numerous mountain torrents water the naturally generous soil; but while the mountains in the rear receive the benefit of the monsoons, the plains are too low to condense the moisture, and they remain half arid outside the narrow margins of the rivers. It is a land of ragged, dry pastures dotted with cacti and candelabra-cerei, and of prickly jungles or chaparral—mostly composed of acacias. The sweltering marshes and lagoons which the rivers create along the Pacific coast support extensive palm-forests. At present thinly peopled, the western lowland of Mexico, if due advantage be taken of the facilities of irrigation, is favourably situated for semi-tropical and tropical agriculture.

Ascending the Sierra Madre, one leaves behind the well-defined belts of vegetation which correspond to an increase of rainfall and mists, and to a lowering of temperature. The valleys become abundantly wooded and display a luxuriance only second to that of the tropical rain-forests, while the ridges remain semi-arid. Further up, the landscape turns more and more to a mountain park, extremely diversified, where pastures alternate with extensive forests of pines, firs, and evergreen oaks. By reason of the variety of climates from

the coast to the summits, it may be said that all the agricultural produce of the earth can be grown in one or the other of these belts of vegetation; from rice, cotton, sugar-cane, oil-, and coco-palms through coffee and maize to wheat, oats, and potatoes. The most important products, however, are coffee and maize, while cattle-breeding is rapidly increasing. Timber is actively exploited in some parts of the Sierra Madre.

The Mexican Plateau—Anahuac. From the Rio Grande southwards, the Mexican plateau rises and contracts gradually, bordered on both sides by a jagged rim of high mountains and broken by numberless short ranges. Extremely dry in the north, it enjoys towards the south a well-marked and fairly regular summer rainfall. Lower and broader, the hot plains of the north still belong to the margin of tropical semi-deserts. They stand intermediate between the arid lands beyond the Rio Grande and those of the Gila, and seem to combine the features of both; cacti, agaves, and mesquites are still predominant. Vast, dreary areas are covered with a modified sage-brush of low, woody, greyish bushes, the most remarkable of which is the rubber bush or guayule. The inland drainage has developed broad alkaline swamps or bolsons accompanied, as usual, by salt-bushes and salt-pastures. Thanks, however, to the mountains, water-sources are numerous, and suffice to supply the extensive cattle-ranches and the industrial towns.

The relief becomes more varied and the rainfall more regular and abundant towards the south and, accordingly, the aspect of the vegetation is more diversified. This portion of the plateau, which rises to 6,000 and 7,000 feet above sea-level, has mild but dry winters and warm and moderately rainy summers. With this

climate, tree-growth requires a well-watered soil; but such conditions are seldom fulfilled, the soil being mostly porous and the inland rivers remaining dry during the greater part of the year, or running in



Fig. 34. Taxodium trees—Sacromonte. Amecameca (Mexico).

very deep cañons, whose lowest parts are frequently transformed into lagoons or swamps with no outlet. The hill ranges, once wooded to a large extent, are now mostly bare. Over the plains stretch vast steppes of scattered wiry bunch-grasses, which are hardly relieved

by occasional groves of low trees. The countless lava sheets, which are strewn over the plateau, are marked by thickets of thorny cacti, yuccas, agaves, opuntias, and acacia bushes. In the moister valleys, which are not infrequent, pastures become quite luxuriant; woodlands and groves of tall trees, deciduous and evergreen alike, thrive and increase; and maize and wheat are extensively cultivated. A notable feature of the upper part of the plateau is the cultivation of the agave whose fermented juice is a popular drink; other agaves are also grown for their fibres. The rural industries of the Mexican plateau depend almost exclusively on the capacity of the soil for retaining the moisture, and on the underground water-supply. Fertile agricultural valleys are not lacking, but over the larger part of the high plain only a modified kind of nomadic life, viz. cattle-ranching, is possible; irrigation, however, will in course of time open up vast territories.

Of the temperate conditions and immense resources of the plateau of Anahuac, its ancient inhabitants, the Nahua, took full advantage: pastoral industries were unknown for lack of cattle, but they practised an intensive form of agriculture and gardening, superior to what was known in Europe at the same period of history; vestiges of it are still to be seen in the 'Valley of Mexico'. The scientific works of irrigation, drainage, and water-supply which these populations carried out brought large areas under prosperous settlement and cultivation, so that when the European Conquistadores, who had not reached the same level of culture, wiped out the native civilization, they were unable to equal or replace those gigantic works.

Atlantic Lowlands of Mexico and Southern Mexico. The Atlantic or Gulf slopes of the plateau are more

abundantly watered than the western Sierra Madre, and possess a still wider range of climate, vegetation, and agricultural possibilities. Fairly dry in the north, the eastern Sierra gradually enters into the moist tropical region, where the succession of vegetations from top to foot of the mountains is broadly as follows: on the upper slopes, which are largely of volcanic origin, there are imposing forests of conifers: in the temperate belt or 'tierra templada' which receives the maximum of atmospheric moisture, the magnificent broad-leaf evergreen rain-forests of the valleys alternate with the tall coniferous forests of the ridges: further down, in the lower valleys, the rain-forest possesses all the profusion and features of the equatorial selva. Yet the rainfall has decreased, and outside the alluvial and well-watered portions, conditions are dry enough to favour the growth of those deciduous, low thornwoods and jungles which, in Brazil, are described as 'caatingas': the broad coastal plain or 'tierra caliente' is divided between the jungle and the grass savanas, on account of its reduced rainfall, but wherever the moisture of the soil compensates for the dryness of the atmosphere, the equatorial forest regains all its power. In Tabasco and Campeachy, mahogany, cedar, dyewoods, Mexican rubber, cacao, and vanilla are among the indigenous forest products. At this southern extremity of the plain, the rainy season, which was so short in the north, has lengthened so as to cover eight to nine months of the year and render the climate regularly hot and moist. This condition is reflected in the vigour of the dark forests which cover the plain and the hills.

Thanks to the breach in the line of high plateaus which is known as the isthmus of Tehuantepec and to the wide opening of the Chiapas valley, the Atlantic

winds penetrate to the heart of the South Mexican mass of mountains, the features of whose vegetation repeat, on the whole, those just described: only the low plateau or plain of Yucatan owes more to the porous nature of its limestone than to its climate and displays a large development of savana and jungle, while the hilly interior is

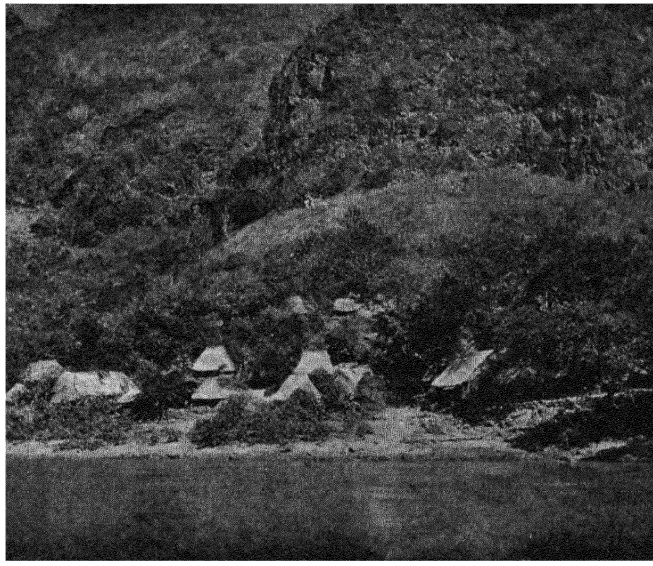


FIG. 35. Dry scrub and cereus-trees on arid slopes. A small alluvial cone, the abundant vegetation of which supports a group of huts—Tuland valley, Mexico.

abundantly wooded up to the heath- or brush-clad table tops. The inland and Pacific valleys are, by contrast, very hot and dry, assuming frequently the character of semi-deserts, with a scant vesture of acacia-scrubs or wastes of cacti and succulents.

The civilizations—high enough according to all available records—that preceded, and disappeared before, the

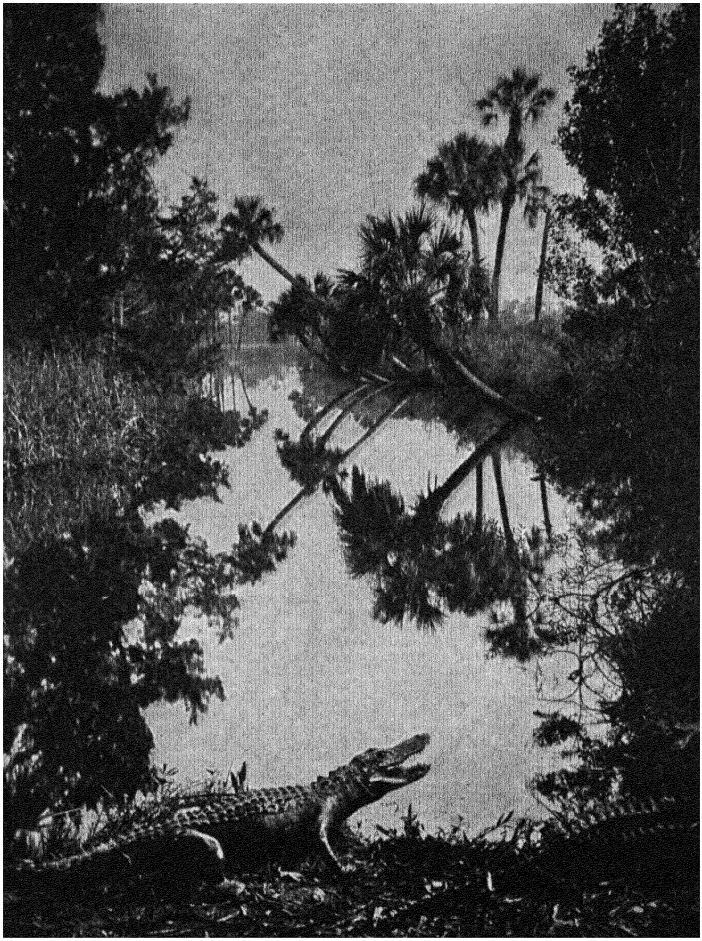


FIG. 36. In a Florida Swamp.

invasions of Europeans, were primarily agricultural; though the Zapotecs and Mayas amongst others have left stupendous ruins in southern Mexico.

Florida and the West Indies. The southern shores of Florida with its Keys, and the low archipelago of the Bahamas, are bathed in the balmy and moist atmosphere created by the warm waters of the Gulf Stream. Under the influence of those favourable conditions, the flora of the warm temperate regions is stimulated to a supreme effort of vigour and beauty; but the admixture of the more profuse plant types from the south is too limited to admit of the variety and luxuriance of truly tropical vegetation, to many features of which the plant-life of Florida closely approximates. Palms, lianas, and epiphytes, while indeed pleasantly common, do not reach the lavish diversity and splendour of form of the intertropical world. This difference seems due to the isolation of the country, the state of sea- and air-currents, and to its geological history, more than to restrictions of the climate.

Tropical conditions are fully attained across the channel, in Cuba, Hispaniola (Hayti), Jamaica, and the Lesser Antilles, which, on the east, span the gap between the two Americas. These islands are so situated as to receive the benefit of the trade-winds. The screen of mountains which forms the core of the Antilles is high enough to intercept the atmospheric moisture and leave the leeward slopes fairly dry; hence a marked distinction between the two sides, which is particularly noticeable in the larger islands. Leaving aside minor differences, mainly in the flowering plants, the features of the vegetation of the West Indies so closely approach those of the mainland of Central America as to admit of a common description. Agriculture is the chief industry

of the islands to-day, as it was in the time of the aboriginal Cebunaya populations (related to the Mayas) which have vanished before the Europeans.

CHAPTER III

SOUTH AMERICA

General. The wealth and variety of forms of plant-life in South America, offered perhaps by no other continent, are due alike to its situation, its extension in latitude, to the height and disposition of its relief, and to its geological history. The greater extent of its area lies between the Tropics within the belts of equatorial rains and trade-winds. The effect of the constant equatorial heat and moisture is enhanced by the development of a huge alluvial plain which they have helped to create; hence the Amazon selva has no equal in the world.

Under the latitudes of the trade-winds, high marginal rims prevent the penetration of the moisture very far inland, a fact which favours the extension of broad savanas. Outside the Tropics, the lofty range of the Andes has the same effect on the westerly winds as the triple barrier of mountains has in North America; hence a similar arrangement in the distribution of the large masses of vegetation, though the Patagonian semi-desert finds no equivalent in the northern continent.

Central America. The whole land, including Central America up to the Isthmus of Tehuantepec, and reaching south to the Gulf of Guayaquil, eastward through northern Venezuela to Trinidad, along the slopes of the Andes and

their prolongation eastward, may be regarded as forming a natural region of tropical mountains.

Varied as its landscape, climate, and vegetation are in detail, this region presents a fairly uniform character: mountain ranges or sierras stretch parallel to the Pacific coast-line, with occasional branches running east and west and an eastern spur forming the coast-ranges of northern Venezuela. Between the steep sierras, deep and sometimes broad valleys open into low sweltering plains. The coast-line on the Atlantic presents a flat and marshy tract of lowland as in Honduras, Campeachy, or Maracaibo; or a narrow belt leading to rapidly rising slopes, as in Venezuela; or, again, a broad, flat, rocky shelf as in Yucatan. Many of the mountain-tops expand into plateaus at 10,000 to 14,000 feet of elevation, and are known in Colombia as 'paramos'. The climate is naturally varied owing to differences in altitude, and falls into a western or Pacific drier portion, depending chiefly for its moisture on local monsoons, and an eastern more rainy portion, largely under the control of the Atlantic trade-winds. The year is divided into a rainy season, which lasts, according to locality, from six to nine months or more, and a dry and burning hot weather. In the south, there are two dry and two wet periods.

On the Atlantic side the coastal plains are covered with a succession of savanas, where light clumps of acacias and other short, fine-leaf trees, or isolated tall ceibas and groves of palms stand conspicuous. They are fringed seaward by arid dunes, either bare or covered with dense, low evergreen scrub, and are interrupted by alluvial tracts of heavy tropical rain-forests, chiefly known for their mahogany, rubber, cacao, vanilla, dyewoods, and palms. The wealth in palms,

however, is not so great here as in other tropical regions. The low, marshy forests are frequently fringed with shallow lagoons, mangrove, or brackish, swamps, which are belted with swamp forests, or hidden by tall and thick hedges of grass and reeds.



Fig. 37. Undergrowth of a tidal 'bayou' in intertropical country.

In many places the forest has been cut down or burnt when a kind of savana takes its place, or plantations have developed, including sugar-cane, coco-palm, cacao, and rubber, along with bananas, pineapple, cotton, maize,

and tobacco, papaw, mango, &c.: rice is, on the whole, seldom grown. This kind of vegetation may be carried to elevations of 2,500 to 3,000 feet.

The slope of the hills, especially where the gradient is very steep, is covered with sparse forests of evergreen oak and strawberry-tree (*arbutus*), or other short, stout trees, resembling in many ways the Mediterranean oak woods. Farther up, the tropical pines make their appearance, and constitute a zone of tall, gloomy forests with little undergrowth. At about 3,000 feet the rain-forest changes its character, and tree ferns, small palms, and bambus become conspicuous in the under-wood, whereas epiphytes, lianas and climbers decrease in size, if not in diversity and number. Higher again this warm rain-forest gives way to another less profuse and lower variety, in which the number of leaf-shedding trees increases until they are in turn replaced by pine forests on the drier ridges.

The high wind-swept plateaus are either lightly covered with thin and stunted pine woods, as in the north of this region, or, at greater elevations, merely clad with a heath-brush, suggesting a bilberry heath. The sierras which rise above the timber line are capped by an alpine zone. Of the Colombian paramos, the lowest may present the appearance of an open bush-prairie, while the highest display a truly alpine carpet of stunted heath, wool-clad plants, low tussocks of stiff grass, or cushion plants scattered over the bare floor. Among these, in groups or solitary, stand the curious 'frailezones', with stout, shaggy bodies, and woolly heads.

In all this region, the inland valleys are, as a rule, much drier than the Atlantic slopes, except where they are open to the north and north-east winds. The

contrast between the Pacific and Atlantic coasts is generally striking; instead of luxuriant forests, the inland slopes display only varieties of dry vegetation.

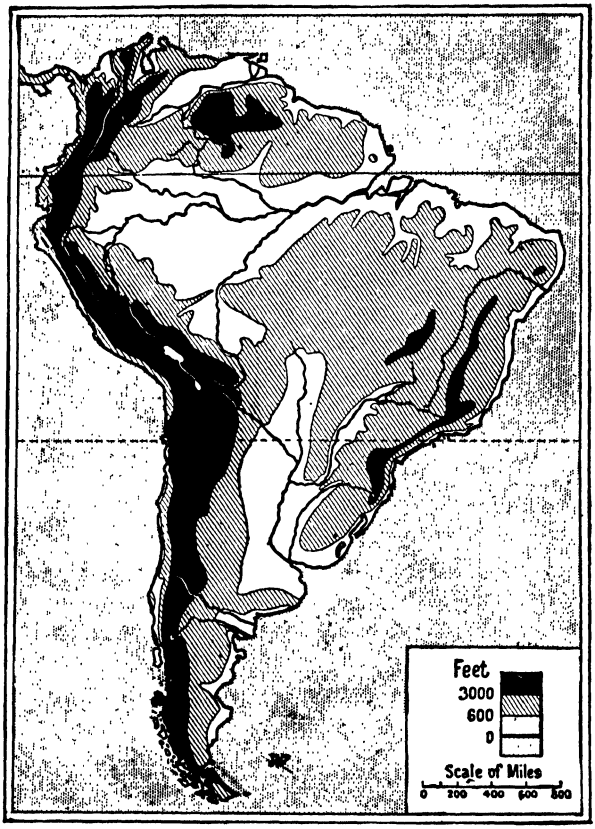


Fig. 38. Physical Features of South America.

Thin, grey patches of leafless and thorny scrubs, vast wastes of cacti, prickly pear, agaves, and prickly acacias, alternate with light evergreen woods. Higher up begin

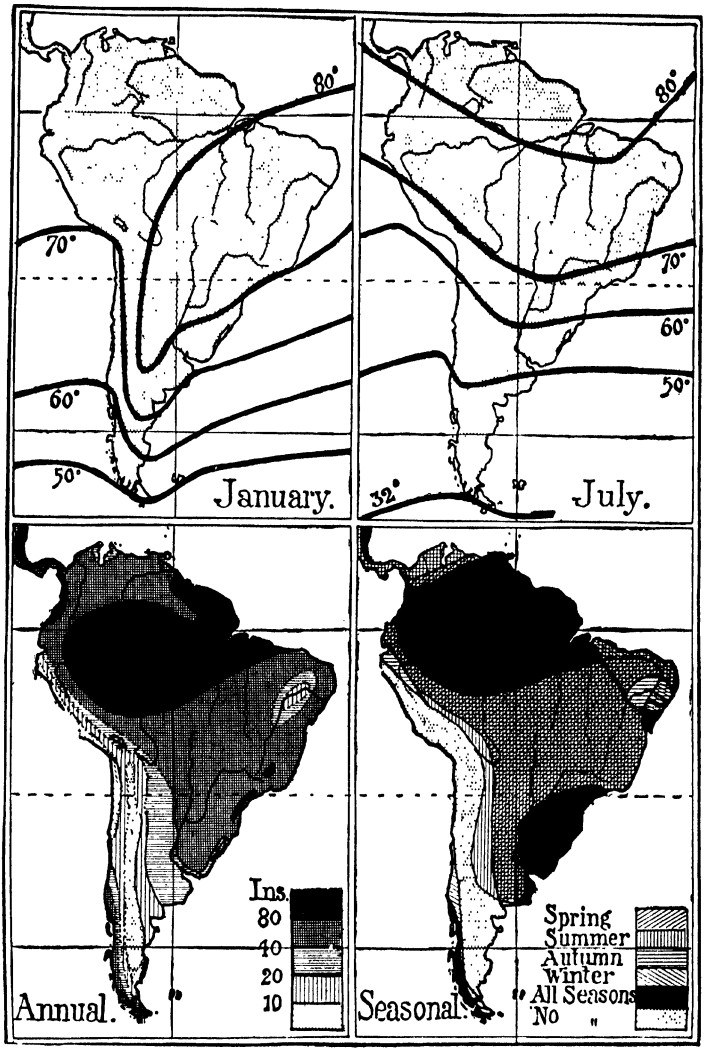


FIG. 39. Mean Temperature of South America in January reduced to sea-level.
FIG. 40. Mean Temperature of South America in July reduced to sea-level.
FIG. 41. Mean Annual Rainfall of South America.
FIG. 42. Seasonal Distribution of Rainfall in South America.

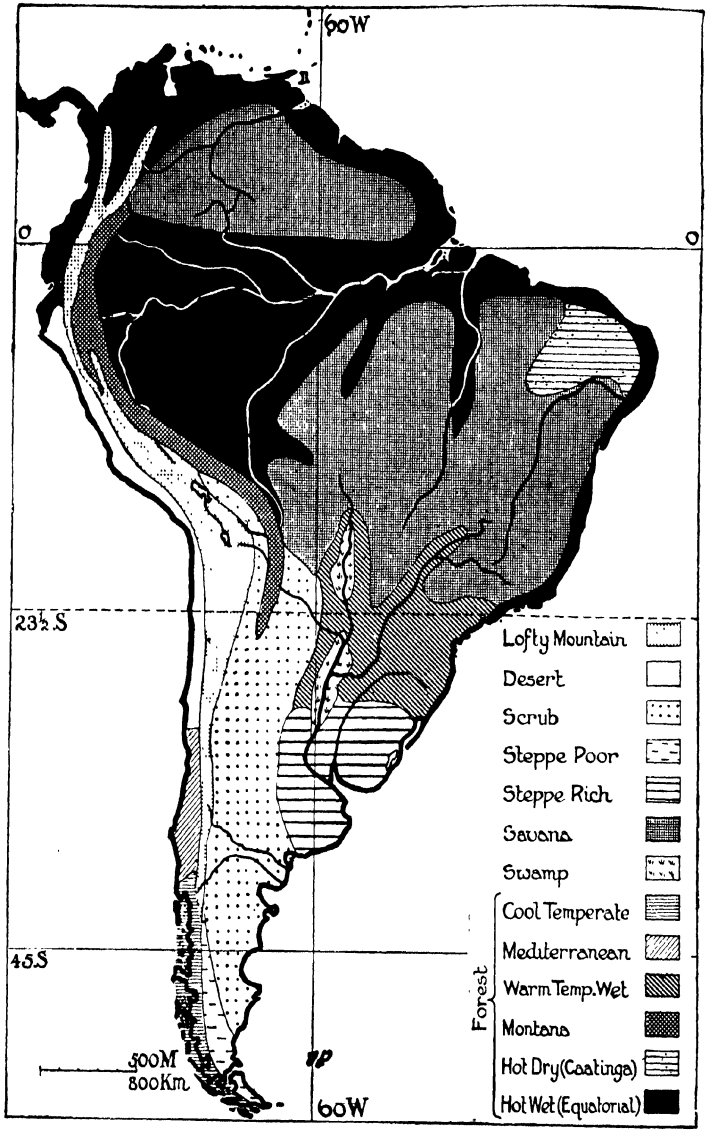


FIG. 43. Vegetation of South America.

more regular forests of mixed pines, oaks, and evergreen, hard-leaf trees and shrubs, strikingly like mediterranean woodlands. The South American species which, in the south, replace the flora of the northern continent, retain the same forms of growth and leave the general aspect of the vegetation unchanged.

In Colombia and Ecuador, the equatorial regimen of rainfall being more strongly felt, the Andean valleys enjoy a richer vegetation of high forests, grassland, and tall jungles. The branch of the Andes which strikes off to the east through northern Venezuela is generally much drier in point of climate; and here lighter tropical forests alternate frequently with barren cactus scrubs and grassy savanas. Much of the forests of those Venezuelan cordilleras has been destroyed and replaced by dreary scrub slopes. The northern sides of the coast ridges are still partly covered with stately trees, due to the moisture of the trade winds, the influence of which, however, grows weaker as range succeeds range towards the interior. The troughs of the valleys are lined with savanas and occasional savana-woods. The ancient native populations of these tropical mountain-lands were, as in southern Mexico and the West Indies, mostly devoted to agriculture. Among those which had attained a fair measure of culture before the invasions of Europeans may be mentioned the Pipil-Quichue of the Guatemalan valleys and the Muysca or Chibcha of the Colombian plateaus, skilled also in arts and crafts, though their civilizations have now been wiped out.

Orinoco Llanos. Between the Venezuelan cordilleras and the Guiana highlands lies an open lowland which extends from the mouth of the Orinoco to the Cassiquiare and the upper Apure. To the north of the Orinoco there is a low mesa which passes southwards to a level

plain, studded in places with granite hills and hillocks, crossed by broad rivers, bestrewn with swamps, and periodically flooded. The climate is uniformly hot and sweltering, with a dry and a wet season, and a fair atmospheric humidity. Dew is abundant; rain, the yearly average of which remains under sixty inches, is not entirely lacking at any time of the year, but is irregular, and severe droughts are not unknown. The vegetation is that of a vast savana chequered by the fringes of river-forests. Tall tufts of grasses, *paspalum* and *panicum*, mingled with tuberous and perennial herbs and evergreen shrubs form the bulk of it, though columnar palms are interspersed in places, and isolated clumps of short, gnarled trees become conspicuous landmarks. On the llanos innumerable herds of wild cattle, deer, antelopes, &c., are swarming. Marshes, overgrown with tall sedges, and conspicuous in the distance thanks to the groves of mauritia palms which fringe them, are frequent, and provide good pastures in times of drought. The granite hills which stand above the plain are clad with tropical forests.

The mesas, the southern foot of which is followed by the Orinoco in its lower and middle course, are of a more rolling character and more park-like in aspect. The depressions are generally occupied by light woods, and the type of country closely resembles the Guiana savanas or llanos, south of the Guiana Highlands. The Orinoco llanos are admirably adapted for grazing purposes, but entirely undeveloped. Why, considering the comparatively high atmospheric humidity and the fair amount of rainfall, the country should not be covered by some light kind of woodland is not satisfactorily explained yet, though perhaps the practice of grass-burning and the heavy grazing may partly account for it.

Guiana Highlands. These constitute a northern outlier of the Brazilian highlands, of which they reproduce the main features: successions of broad terraces broken by sunk valleys and rising in steps, with remnants of mesas forming ridges or plateaus. Some of the mesas reach elevations of from 6,000 to 11,000 feet.

The Guiana tableland is isolated and open both to Atlantic and equatorial winds; it has therefore more rain and is cooler than the surrounding plains. The northern and eastern lower terraces are clad with dense rain-forests, while the valleys share the savana character of the lowlands, of which they are the continuation. On the slopes, half-way up, rise open woods of evergreen trees with a hard, leathery foliage, recalling our ilexes and laurels. To these, with increasing elevation and rainfall, denser forests of a warm temperate type succeed, to give way in turn, farther up, to an open park landscape of fresh green swards and clumps of low, stunted trees. The higher tables are treeless steppes. In respect of structure and vegetation, the Guiana tablelands recall the Uganda plateau, with the advantage of a more abundant rainfall.

A belt of rolling savanas fringes the tableland on the south and west, and separates it from the Amazon selva. The aspect of those 'campos' differs somewhat from that of the Orinoco llanos. They are rolling wolds, treeless, and covered with large tufts of tall grass, *panicum* and *paspalum*, which are sometimes broad-leaved and four to six feet high. These grasses become shorter on the back of the ridges, and are abundantly interspersed with bulbous and tuberous plants, and thorny bushes. The troughs, dales, and hollows, often marshy or damp, form islands or belts of thin low woods, where palms are a conspicuous feature, the round patches

in the hollows being locally called 'capões'. The trees are mostly bushy and deciduous, often, however, with hard much divided leaves, or thorns and prickles, *rhopala* and *swartzia* being the best known.

Though the rainfall appears to be low in the Guiana savanas, night-dew is always abundant, accounting for

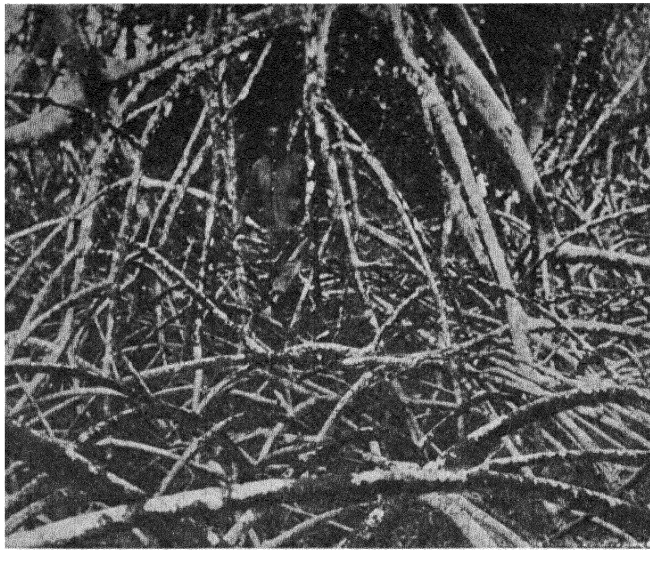


Fig. 44. Tangle of Mangrove roots at low tide, British Guiana.

the grassy character of this belt, which passes, almost on all sides, into the tropical selvas. Such campos are but sparsely peopled, and hardly tilled except for local crops of maize, cacao, sugar-cane, and manioc.

To the south, the undulations gradually disappear, and the park landscape becomes more and more crowded till the tall and gloomy Amazon selva is reached.

Guiana Lowlands. The Atlantic slopes of the Guianas and their foot-hills are under the influence of the equatorial rainfall and enjoy a double wet season, while there is never complete drought. For this reason they are densely clad with heavy forests, only interrupted by occasional clearings of savanas on the watersheds of their short streams. The low coast-belt with its shallow coastal shelf is one of lagoons and luxuriant mangrove swamps, teeming with animal life, extremely unhealthy, girt in by brakes of tall reeds, sedges and grass, or overhung with low, swampy forests and jungles. This belt may extend ten or twenty miles inland, and is succeeded by the tall rain-forest, itself a northern spur of the Amazon selva, from which it does not differ in any material point. Cocoa, rubber, palms, spices, and sugar-cane are the chief products of the Guiana lowlands. The Demerara district is an important sugar centre, while the rubber and the gum (*balata*) of the Guianas are valuable.

The Amazon Basin. This most extensive of alluvial plains is famous for its wealth of equatorial rain-forests, of which it offers the most perfect type. Its flat surface is hardly varied by the scattered undulations or low hills, while the land is regularly flooded by the mighty river, sometimes for twenty miles or more on both sides, and is thus transformed into an inland sea. Of the climate little need be said: an equable high temperature throughout the year and day—about 80° F., a regular and plentiful rainfall, with two seasons of heaviest precipitation, give the very conditions for a maximum and uninterrupted growth; but it may be added that the mighty network of the trunk river and its innumerable tributaries is more efficient for irrigation than for drainage. There is no combination of physical conditions

in the whole world more favourable to vegetation than that which the Amazon plain provides, and we may regard its luxuriance as the supreme effort of plant-life at this period of the world's development. This is expressed in the indescribable wealth of tree growth, in the forest *par excellence*, called by Humboldt 'hylea', and by the Portuguese the 'selva'.

The vegetation, monotonous though it appears to the traveller, has been divided into a number of characteristic formations or associations.

Flood Forests. The banks of the streams, periodically flooded and having an excess of water, are characterized by a peculiar type of forest called the 'igapú' or 'caa-gapu' (the rebalsa of the Spaniards), extending as a broad fringe bordering on the rivers. It finds an exact replica in the flood-forests of the lowlands of the Mekong (Siam) and in the sundarbans of the mouth of the Ganges. From the slimy, hardly solid mud has sprung a rank and dense growth of tall trees overgrown with a continuous drapery of lianas, thus forming an unbroken dark canopy, a green wall impenetrable from outside. It forms a gloomy, stifling, musty, shady, damp vault, supported by innumerable pillars, and choked with a perfect tangle of climbers inside. The plants, simply gorged with water, but feebly rooted in the mud, support each other, tied together by the lianas. This igapú is remarkable for its wealth in palms and its poverty in flowers, and is particularly well developed on the innumerable sluggish side canals or 'igarapís' that intersect it. When the rivers are in spate its canopy simply rests on the water. It is the home of the Pará rubber-tree (*Hevea braziliensis* or *seringeira*), the tapping of which gives employment to a roaming, half-wild, and scattered population

of Meztisos. The igapú differs in character according as it borders on so-called white or black rivers, and is sometimes replaced by miriti-palm forests (*mauritia*).

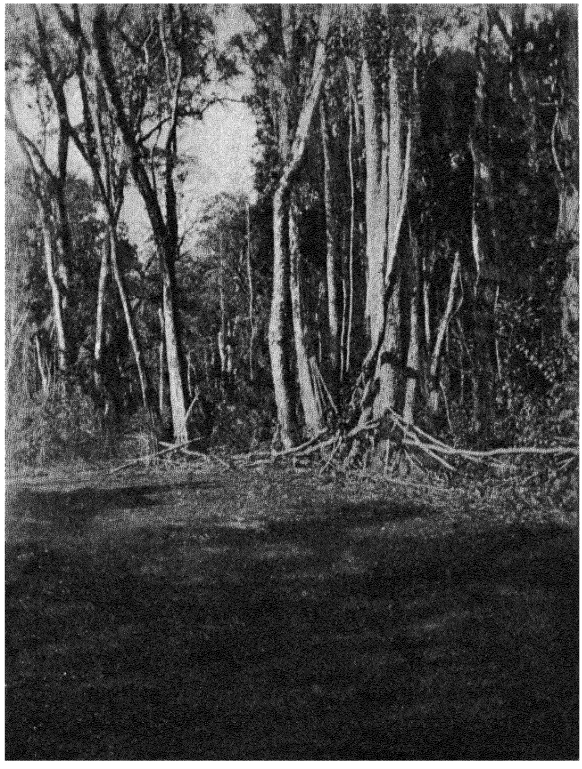


FIG. 45. Swamp forest with roots of trees sticking out above flood level.

Caa-guazu. Beyond the limits of the flood-forests, the typical selva or ete or 'caa-guazu' extends on firmer ground. It is taller than the former, and the trees reach a larger size and have a more solid structure. It is also

more flowery, poorer in palms, but richer in tree lianas and broad-leaf epiphytes; the foliage of the tall trees is smaller and harder. The best-known constituent is the pará- (Brazil) nut tree (*bertholletia* or *castanha*), and where it becomes abundant, the forest takes the name of 'castanhal'. Here again cacao-trees grow wild in the undergrowth. The tall primaeval forest is often burned down to allow of temporary plantations of sugar-cane, maize, or mandioca, and in its place soon rises a dense, ungainly brush, made of all the undergrowth plants and shrubs. Until the forest proper has been restored this brush is called the 'caapuéra' or 'capoeira'. The caa-guazu is as yet little known, thanks to its forbidding nature. It is to all appearances but sparsely inhabited, most of the settlements being along the rivers, for waterways are the sole means of communication. Only wild tribes of Indians wander amid the fastnesses of the overwhelming forest, at perpetual war with the intruder, and living a lazy, primitive life, much like that of the dwarfs of the African selva. On the west, the selva merges into the 'montaña' hill-forests of the Andes.

On the low and slowly rising watersheds between the large tributaries, the backwoods of the Great Forest are thinner, lighter, and lower, a condition approaching that of the backwoods of Central Africa. This appears to be the case also with the unexplored low tablelands extending from the Madeira to the Tocantins, where large campos or parklands are believed to stretch between the wooded valleys.

Thus vegetation seems to be arranged in broad belts from the rivers: the igapú, the caa-guazu, the lighter forest or woodland, and the campo. In the forest, the collection of rubber and castanha occupies several thousands of natives.

Brazilian Coast Forest Belt. The Brazilian highlands, rising gradually towards their eastern margin, have their edge much indented by short, deep valleys: this ragged edge is known as the coastal range or

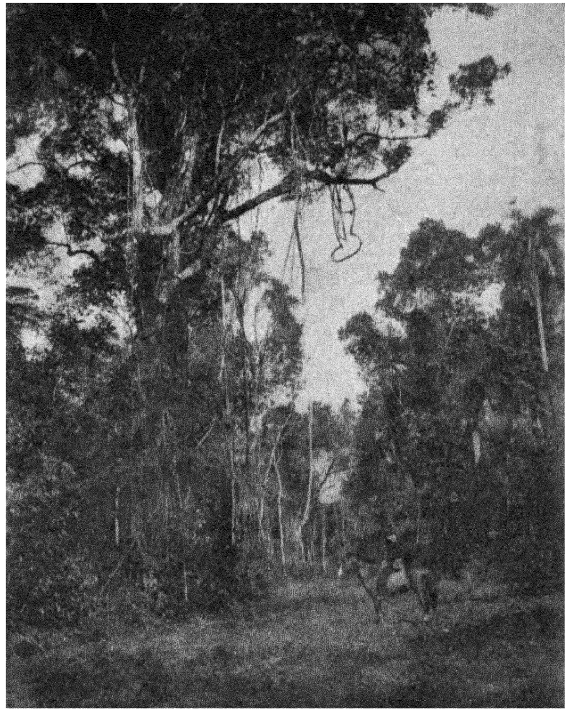


FIG. 46. Forest cutting—Eastern Brazil.

Sierra do Mar, and in places a second and inner line of bluffs appears, making a double range. The coastal shelf, which extends between the sea and the slopes, varies greatly in breadth, and sometimes disappears completely.

The broken ledges and bluffs of the tableland lie fully open to Atlantic winds, of a monsoon type in the north, but trade winds in the south. The proximity of the sea, the modifying influence of the moisture, which is fairly regular throughout the year, give the coast sierra a hot and equable climate with an abundance and constancy of rainfall. Hence the forest which clothes its seaward slopes and the coastal strip extends almost uninterruptedly from Pernambuco to Porto Alegre. It preserves a tropical luxuriance far to the south of the Tropics, and passes slowly to an impoverished type towards its southern limit. It bears in the main the stamp of the Amazon flora, but is somewhat reduced, both in size and variety. Palms play a prominent part in its composition, but lianas and epiphytes are less varied and less strongly developed. The transition from the purely equatorial to the attenuated tropical type is so very gradual that no line can be drawn anywhere. The coastal forest-belt of Brazil finds an equivalent in many respects on the eastern edge of the African tableland in a similar situation, but the African coastal forest-belt is poorer, drier, and more broken: an exact replica will be found in East Madagascar. The lower zone of the hill-barrier, the richest in luxuriant palms, is known for its Brazil- and jacaranda-woods; the temperate zone is marked by tree-ferns, *alsophila* and others.

Through the breaches in the edge of the plateau the forest is sometimes carried far inland and mixes with the flora of the campo; south of the Tropics the upper belt contains araucarias. A portion of the coastal forest-belt is now being used for tropical agriculture, but the encroachments are so far limited, and the forest still largely preserves its character of 'matto virgem' or virgin forest (igapú).

East-Brazilian Highlands. The Amazon luxuriance of plant life gradually diminishes over the coastal lowlands, to die out towards Maranhão. To the east of this, and down to Uruguay, stretches a vast and dry tableland, covered with a more varied vegetation, which may be divided into a northern part as far as the Tropic of Capricorn and a subtropical part farther south.

Northern Portion. The vast tableland is very much broken by swift rivers running in deep valleys well below the general level. It is carved into a distinctly hilly landscape in the north-east, while it assumes a smoother and more rolling surface to the south-west. The climate is of a dry and hot description, with a well-marked rainy season lasting from three to five months. The variations of temperature, both seasonal and daily, are great, ranging from 60° to 100° F., and increasing still farther inland. The rainfall varies from 20 to 60 inches, and shows great yearly irregularities.

In consequence, the character of the vegetation is alike drier, poorer, and more varied than in the Amazon basin. It ranges from the half-desert through the savana to the light type of tropical forest. Chief among the features of the hilly north-eastern corner of Brazil, which may be called the 'sertão' or half-desert, come the dreary white woods or 'caatingas'. These are bare and tangled jungles of low thorny tree-bushes, interspersed with umbrella-shaped *spondias* and *zizyphus*, with swollen, water-storing bombax, and prickly candelabra cerei, opuntias, and cacti, covered in places with epiphytic bromelias, tillandsias, and orchids. The woods are green and flowery for four to five months, but look as if dead for the remainder of the year. The lower bush, on rocky wastes, is even drearier and thinner, with gnarled and stunted prickly acacias,

cerei, and rigid agaves and bromelia plants, predominating: this is the 'carrasco'.

The sertão proper, thinly bestrewn with prickly bushes and aloë-like plants, is the next and most barren term of those forbidding vegetations; where all grades of transition-forms abound, though grass-lands, which predominate farther west and south, are here scarce and of a limited extent. Diverse palms mark these aspects of the landscape: *attalea* characterizes the caatinga: the waxy *carnãuba* palm forms oases round shallow marshes, and gives its name to the province of Ceará: buriti palms form stately groves in some places, and *cocos coronata* again distinguishes the southern sertoẽs. Both carrascos and caatingas are difficult to bring under cultivation, and the country is thinly peopled.

Towards the south and west, in Goyaz and Matto Grosso, the sertão passes slowly into regular campos or grass-lands. The campos here recall the typical rolling savanas: tall, dull green, hairy grass-tufts, showing between them the red or white soil, with various shrubs, dwarf-palms, and liliaceous plants, form the background of the landscape. The treeless savana is called 'campo vero'; but liliaceous trees resembling yuccas may occur, in which case the campos are called open or 'abertos': if the savanas are strewn with clumps of low trees, they are 'serrados'. The trees are short and stunted, with a divided foliage, sometimes deciduous, sometimes with small leathery leaves. The campos in the hollows present frequently circular islands of evergreen trees called 'capões', or regular, leaf-shedding, light woods, taller and denser, 4 to 7 metres high, with an undergrowth of cerei, acacias, and prickly carpet-forming bromelias. The course of the rivers is marked by high and thick hedges of river woods, some of which

recall the luxuriant selvas. A conspicuous feature of the landscape is formed by the 'chapadas' or flat, elevated, grassy tablelands, which may either be dotted with trees, or constitute a regular parkscape of grass and woods.

Cattle and horse breeding, with the cultivation of maize, mandioca, and beans, and other tropical produce for home consumption, are the main occupations of the sparse and widely scattered population.

Southern Brazil Highlands. In the upper basin of the Rio San Francisco, and farther south, the tableland rises by steps to altitudes of 3,000 and 4,000 feet, with occasional higher ridges, thrown into mountains on the eastern margin. These upper highlands have a more extreme climate than those just described. While the maxima of temperature keep very much to what they were in the equatorial parts, the minima descend very low indeed. Snow and frost are not unknown; and the seasonal and daily alternations of heat and cold are strongly marked. The rainfall is somewhat higher than in the northern region of the highlands, and varies from 50 to 60 inches. Rain occurs chiefly in summer, while the winter may be very dry.

Under such conditions, the tropical savana and the dry bush aspect of the northern region give way to a more temperate type of vegetation. Already in Minas Geraes, the savana differs strongly from the sertão aspect. Here the grass is short. The campos resemble treeless steppes, or they are interrupted by carrascos, bushy tracts, expanses of perennial herbs, and groves of coconut-palms. The slopes of the valleys may be strewn with a low brush, while the troughs shelter subtropical forests.

The most conspicuous feature, however, is the appear-

ance of the araucaria near the source of the San Francisco. The umbrella-shaped *araucaria brasiliensis*, which appears at high altitudes in the coastal ranges, gradually extends inland south-westward, to become a feature of the plateau and form light forests much interrupted by campos. These forests display either

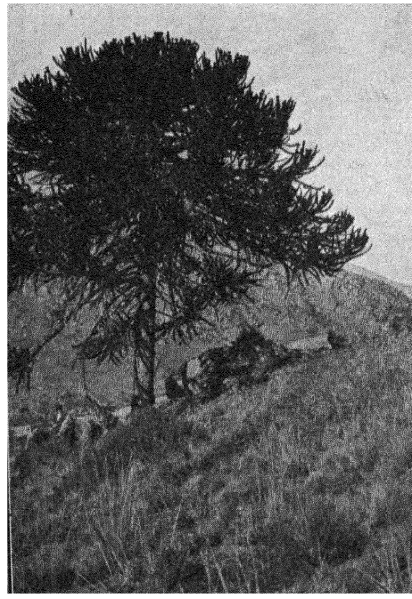


FIG. 47. *Araucaria imbricata* (Chile pine).

a sward of short grass, or a thick undergrowth of evergreen shrubs, chief among which comes the yerba maté or Paraguayan tea. The araucaria descends to lower altitudes as the latitude increases.

In the southern states of Brazil, the country west of the coast-range slopes inland by a succession of broad

terraces, the upper ones of which, nearer the sierra, are treeless grass-lands, whereas the lower inland terraces are clad with stately forests of araucaria and yerba maté to the brink of the highlands. To this region also belongs the hilly territory of Misiones, a spur of the wooded highlands protruding into the grassy campos of the lower Paraná.

On the higher ridges, the climate is cold enough to favour a truly alpine vegetation: short close swards, dwarf bushes, and cushion-plants. Owing to the rise of the highlands and consequently the more temperate climate, the dry tropical vegetation of the northern highlands has now changed to a decidedly subtropical, indeed temperate type. These conditions have encouraged the settlement of numerous European colonies, the chief occupation being cattle-raising and mining; cultivation, however, is not wanting. São Paulo is well known for its coffee, while everywhere manioc is grown for home consumption, and there is a promising field also for the fruit industry. Wheat has been grown on the higher levels.

The savana becomes almost exclusively predominant on the watershed plateau between the Amazon and the Paraná basins.

Matto Grosso and West Goyaz. In this region, the plateau, on the low divide of the Amazon and Paraná basins, assumes a more strictly table-like appearance: broad valleys are sunk deep below the flat level of the land. There is more rain, due perhaps to some monsoon influence from the Amazon. The country has been little explored, but it seems to continue southward the campos of the backwoods of the Amazon, and may be conceived, as far as known, as a typical tropical savana of the 'chapada' description. The deep valleys with their

steep slopes are clad with luxuriant selvas of the Amazon type. This configuration appears to be continued south-west to the edge of the plateau, beyond which, in lower Matto Grosso, the plain assumes a rolling

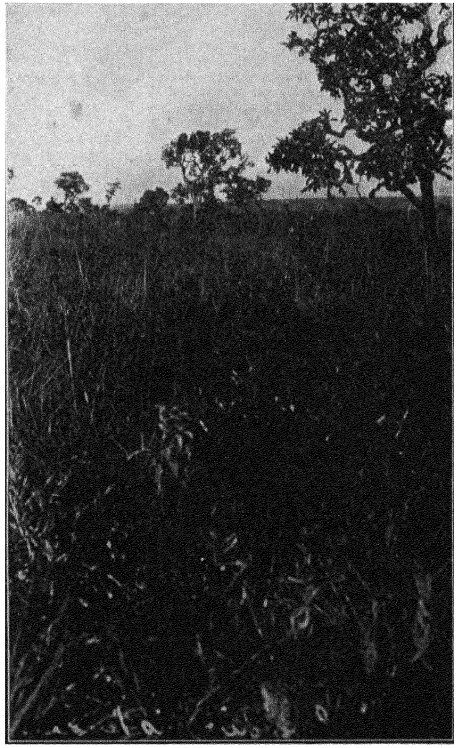


FIG. 48. Brazilian Savana, Matto Grosso.

character, without materially changing the nature of its grass carpet.

The country is scarcely inhabited but for warlike Indians, and for obvious reasons most of the human

settlements are located along the rivers: there is ground for thinking that it will become a rich pastoral region.

Bolivian Llanos. The region comprised between the upper Madeira and the Chaco, the Guapore and the Montaña of the Andes, is almost unknown. It consists, probably, of extensive llanos intersected by broad rivers and vast marshes, with a predominance of grassy savanas resembling the llanos of the Orinoco, though reedy swamps, groves of palms, and clumps of forest are common. In the province of Santa Cruz, the occurrence of hill ranges has induced the growth of dense forests of a thoroughly tropical nature. The few data so far collected about these savanas authorize the belief that here lies a country rich alike in possibilities for stock-raising and agriculture, and able in a distant future to support a dense population. The grass-lands are continued along the foot of the Amazon plateau, and join over the upper Paraguay River with Matto Grosso and Goyaz.

Chaco. The broad strip of country which extends from the swamps of the Paraguay River to the Andes consists of flat or, in places, hardly undulating land, beyond the limits of the floods of the Paraguay. Its climate is dry and hot, but the uncertain drainage retains in the soil in many parts a fair amount of water, and gives rise to marshes. The nature and quantity of the water in the soil seems here to control entirely the distribution and character of the vegetation. On the flat portions, just beyond the limits of floods, extend vast tracts of thorn woodlands, the quebracho tree being the predominant feature, with its gnarled, twisted form, and extremely light crown of small, hard, finely divided leaves. The undergrowth is a dense and tall brush of evergreen

hard-leaved shrubs, while grassy glades occupy the intervening lower and moister ground. The almost imperceptibly swelling surface is thus distributed between the meadow-like, somewhat marshy shallows and the dry quebracho woods, which then appear like islands or 'islas' on the flats. Thin forests of waxy palms grace the grass-lands and belt the forest: the swamps which are strewn over the surface disappear under tall wavy reeds and sedges. The northern Chaco is said to contain patches of moist tropical forests, and gradually merges into the Bolivian llanos. The great park plain is interrupted by the vast and impassable swamps of the Pilcomayo and the Bermejo.

As the land rises towards the Andes very gently, and with increasingly dry climate and soil, the quebracho forest gradually thins out, becoming lower and sometimes passing into a thorny scrub-land of various small-leaf, prickly bushes, such as *prosopis, acacia, mimosa, cassia, chañar,* &c. Even this thins out in places, and leaves desolate stony wastes dotted with single scraggy shrubs of *acacia, atriplex,* and scattered *cereus* and *cactus.*

In Tucuman and farther north along the Andes, the upper plains are more fertile, owing perhaps to increasing altitude and, consequently, to a somewhat more liberal rainfall. Dry forests of quebracho reappear with increased vigour, and other forests are known here which are almost entirely composed of cebil acacias, alternating with a dry kind of narrow-leaf grass-land, and making the park landscape known as 'parque.' This links the plains with the luxuriant forests of the sierra. Quebracho forests are now being developed for their hard timber and bark, whilst the grass-lands are used for grazing.

Horse and cattle breeding have so far been fittingly

the main occupations of the region, but the existence of the dry woodlands is an indication of further possibilities in the west. Orchards of subtropical and mediterranean fruit-trees may take the place of the forests, and indeed have already done so to a certain extent. Orange orchards, amongst others, find here very favourable conditions, and a kind of mediterranean agriculture is followed. Sugar-cane is extensively grown in Tucuman.

Alto Paraná-Paraguay. The land which is limited by the lower course of the Rio Paraguay and of the Alto Paraná differs alike from the Brazilian highlands and the Chaco, from the campos of Matto Grosso and the campos and swamps of Corrientes: it constitutes a natural region.

Covering the southern lower terraces of the plateau of Matto Grosso, and sinking abruptly along a bluff down to the alluvial plain of the Paraguay River, it is on the whole gently undulating and seldom rises above 1,000 feet in elevation.

The climate is equable, though hot in summer. The rainfall, fairly well distributed throughout the year, ranges from 50 inches on the banks of the Paraguay to 80 inches on the Alto Paraná: dew is very abundant at night, and the seasonal rhythm is well marked. This is typically a moist subtropical region.

It is correspondingly covered with luxuriant forests in its eastern moister half, and in that respect may be compared with the middle belt of the eastern Andes or, farther afield, with the lower belt of the Chinese Alps. Lianas, epiphytes, and palms of great variety and large size show above a particularly dense and tall undergrowth. Many of the tall trees of the canopy shed their foliage for a short time in winter, whilst the undergrowth, almost a forest in itself, is thoroughly

evergreen. Tree ferns are always present in the gullies. On the more porous soils the forest is reduced to a tall and crowded deciduous jungle, among which is found the yerba-maté, somewhat resembling a broad-leaved laurel.

With the decrease of precipitation towards the west, the forest, without changing its density and character,



Fig. 49. Paraguayan Forest near Guayra Falls.

remains limited to the rises and undulations. Tall grassy campos, sometimes studded with palms or scattered thickets, intermingle more and more with it, finally predominating on the lower alluvial levels which gradually lead to the marginal swamps of the river Paraguay. Each of the numerous rivers throws up at flood time a double high bank clad with a varied and thick

jungle. These forests yield a large number of most valuable kinds of timber, while the yerbal jungles provide employment for thousands of men engaged in the collection of the Paraguayan tea. No country is better suited to rich subtropical crops than the Paraná portion of this region: the western pastures are excellent, and the sparse population is now half agricultural and half pastoral. The Conquistadores found there a great

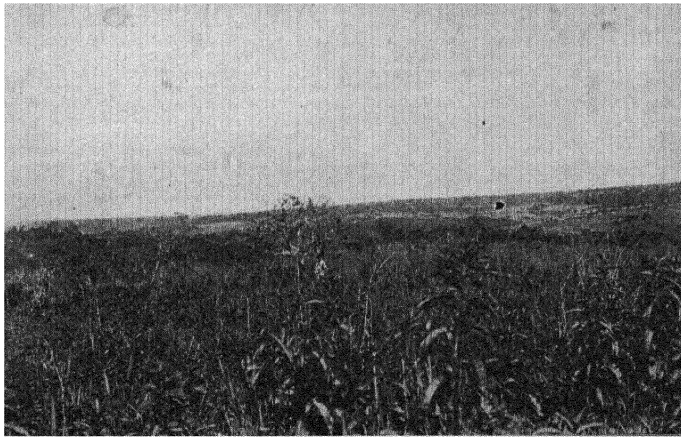


FIG. 50. Campos in North Paraguay.

number of tribes, some of whom lived entirely on the natural products of the forest and river, though others were skilled in agricultural pursuits.

Paraguay and Lower Paraná Marshes. The Paraguay River and its powerful tributaries, the Pilcomayo and Bermejo, run through vast level plains, studded with a few conical knolls, and invaded yearly by floods bringing deposits from the Andes and the campos of Matto Grosso. So flat is the basin that rivers frequently

shift their courses and intersect the country with disused channels and vast swamps, throwing up levees on their

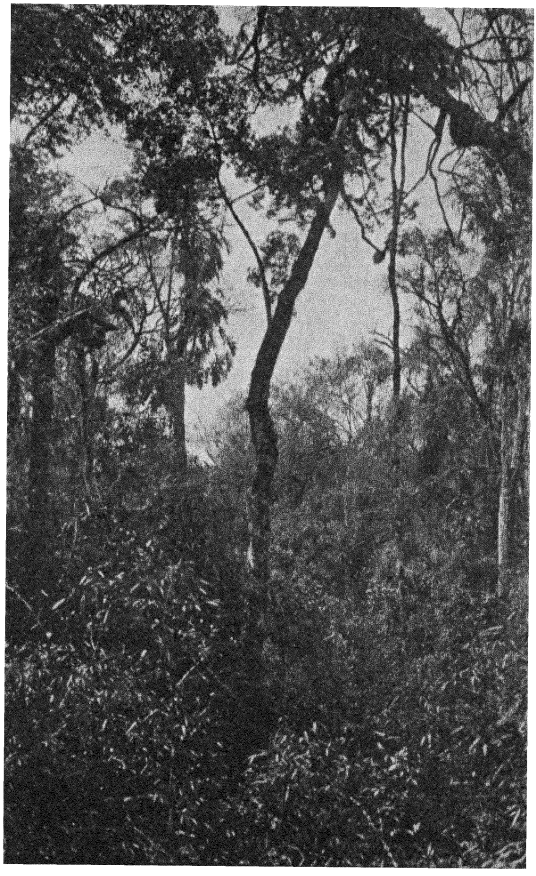


FIG. 51. Subtropical Rain Forest, Paraguay.

way and damming up whole territories. Though the climate is dry and warm, with the exception of a rainy

season, the riparian region is turned into a huge swamp similar to those of Central Africa, on the Nile or the Zambesi. The same type of landscape holds farther south, and is strongly marked on the lower Paraná; thus a broad strip of land extending along the upper course of the Paraguay down to the Apa River, continued in the Chaco west of the Paraguay and expanding

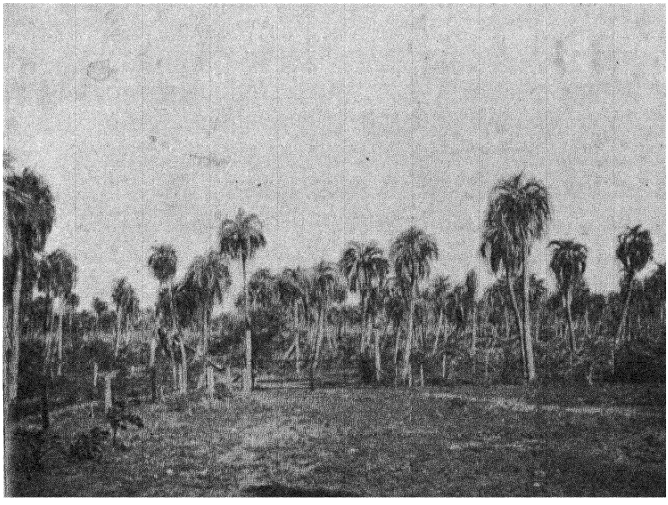


FIG. 52. Palm Grove in Corrientes, Argentina.

into Corrientes and Santa Fé down to La Plata, may be detached as a separate region. It consists of vast level, grassy seas or pampas, and equally vast swamps.

The swamps may be shallow, 'bañados' or deep, 'malezales', sometimes deepening into actual lakes: they are overgrown with tall reeds, sedges, and broad-leaf grasses, often six feet high. Along the uncertain shores of the

lakes, the reed vegetation is constantly encroaching, building floating islands of intertwined reeds, natural rafts called sudd, which sometimes support trees and are torn and carried away in times of flood. Such sudds, floating down lakes and rivers, are a common sight. Some of the rivers, even the Pilcomayo, lose themselves in impassable swamps, where the firm ground and the loose muddy floating islands are hard to distinguish. When the ground dries up, the reeds shrivel and disappear. A short grass, followed at first by a carpet of low, and later on by a crop of tall, herbs and bushes, springs up, affording succulent grazing grounds for horses and cattle, but sadly infested by myriads of mosquitoes and other pests.

The river banks disappear under hedges of tall canes, wavy reeds, and bambus, so that dikes and sand-banks thrown up by the waters are, in many cases, the only dry roads. These are soon clothed with a luxuriant covering of herbs, thanks to the seeds carried by the streams and scattered in the mud and sand. Bushes and trees strike and grow quickly and deck the levees with impassable low jungles, recalling our osier beds. The islands thus enclosed by the dikes become wet meadows or grass moors strewn with 'bañados'. They may be locally dotted with thin copses of bushy acacias, or give rise to palm forests.

Such is the power of those changeful and unsettled rivers that the surface of the country is in constant process of transformation by the periodical flooding of the pampas or the draining of marshes, but the banks along the streams may be firmly held together by the vegetation and even become permanently wooded. Advantage is taken of this by man for his settlements, roads, and railways: thus it happens that frequently

the banks of streams only are inhabited, while the hinterland is impassable. The islands of really firm ground, above the level of the floods, and yet irrigated by them, may also become centres of forest growth. Tropical in the north, the forest belts and islands assume a decidedly subtropical, and even temperate, character in the south. As might be expected, the chief industry of the region is cattle and horse breeding.

Western Argentine Wastes. West of the latitude of San Luis, the landscape, though retaining the name of pampa, slowly changes for the worse. The rainfall is well below 20 inches yearly, and there is a prolonged dry period; the variations of temperature are therefore very wide. The ground also becomes somewhat rougher and more varied. Immense levels and hollow tracts of marshy or salt deserts—the 'travesías'—are broken by sandy dunes—the 'medanos'—some of which are shifting. An outlier of the Andes, the Sierra de Cordoba, is thrown athwart the track to the Cordilleras, and more or less encloses the desolate land on the east. Isolated hills or hillocks here and there break the rolling or level surface.

The vast plains at the foot of the Andes, under these latitudes, gradually pass from the grassy pampa into a vast dreary thorn shrubland. The grass grows sparser and sparser westward, where low compact bushes, with small, hard, divided leaves and formidable spines, are spread like cushions here and there on the naked ground. They belong to the typical bush of West Argentina, the chañar, somewhat like an acacia, which is everywhere conspicuous. Shrubs of hard-leaf, prickly verbena and of retama, tufts of dwarf prickly palms, stand solitary, whilst more forbidding leafless cacti, cerei, and opuntias stretch the ungainly shapes of their bristling limbs.

There are oases along the margins of the rivers, fed by fresh water, which afford only limited fields for a mediterranean agriculture.

From these bushlands one rides into the 'esteros' or 'salitrales', i. e. vast salt-wastes, where the bare ground is shrouded in a white sheet of salt powder, or may be flooded for miles round in times of rain. Dotted here and there are shrubs, high or low, with small, fleshy,

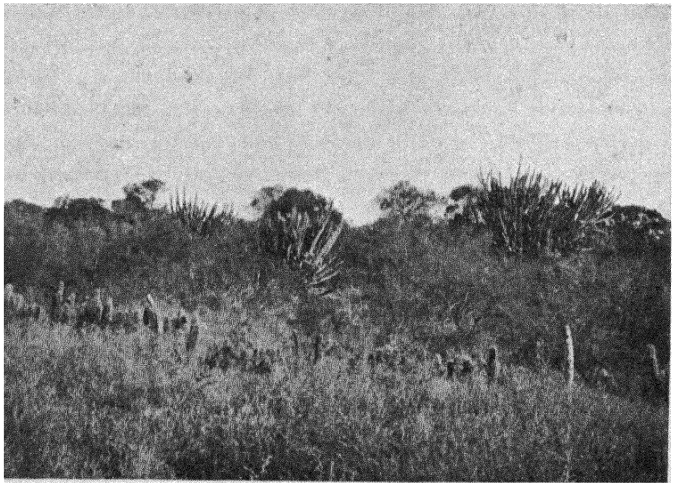


FIG. 53. Chañar and dry cereus scrub, W. Argentina.

grey leaves in tufts, growing sparser and lower with an increasing proportion of salt, till the soil remains naked but for a few distant, crawling dwarf-bunches. Plants of these parts somewhat resemble those of our own salt-marshes, and have a similar aspect the world over: such are the 'junin' wastes.

At the limits of the salitrales, the land rises into

barren dunes or medanos, some of them shifting; and studded with tall tufts of dry, small-leaf *Compositae*, such as *baccharis*. They grow out of little mounds, between which the sand has been washed or blown away. Misshapen opuntias and cerei are strewn here and there among besoms of stiff grasses. The rivers, many of them salt, are fringed with pampas-grass, which appears also on the rare brackish or fresh-water marshes or 'pantanos' and in the hollows.

The little rocky sierras and isolated hills, like the sierra of Cordoba, are not, strictly speaking, redeeming features, for their stony slopes are mostly barren, and vegetation is scarce. Occasional low trees become conspicuous landmarks amid a dry scrub of schinus, larrea, and other bushes, recalling the chaparral of California. Even the scrub frequently thins out and scatters, leaving nothing but a jumble of rocks.

The Pampa. 'On every side a sea of grass, grass and more grass: *paja y cielo* (grass and sky), as the natives of the country style their favourite landscape. Nothing to break the brown eternity of the pampa but here and there a green ombú, shaped like an umbrella, or an occasional straggling line of pampas-grass, which breaks the edges of some water-course, and by comparison seems as tall as does a poplar in the plains of Lombardy.'

This describes the true pampa, extending from the Atlantic, half-way over the continent, to the longitude of San Luis, and from the lower Uruguay south to Rio Colorado. The name pampa has, however, been extended to other treeless, flat tracts surrounding the 'pampa vera'.

The pampa is entirely level, or slowly and gently undulating, sometimes swollen into low mounds; the

hollows, mostly shallow and devoid of outlet, collect the waters, and dot the surface of the boundless plain with innumerable marshes, brackish or salt, or merely damp troughs; the soil is a stoneless, fine sand, or sandy and powdery loess; the rivers are often saline, and thanks to the alternations of droughts and heavy downpours, the soil is caked hard and rendered impervious. Winters are short and comparatively mild, though distinctly felt; daily ranges of temperature are stronger than in the north, and nightly dew is abundant.

The carpet is made of separate dense tufts of stiff grasses, not in a close mat, but showing the ground in the intervals. According to the nature of the numerous grasses—melica, stipa, aristida, andropogon, pappophorum, panicum, paspalum, and others—the aspect varies slightly. Herbs, mostly evergreen perennials with small leathery leaves, are interspersed among the grasses; bulbs are not as abundant as might be expected, and annuals are few. Trees are excluded but for occasional and solitary ombús (*phytolacca*) which grow near the houses. Rivers flow either between sandy banks or tall hedges of gynerium, pampas-grass and reeds, forming what is called 'pajonales'. In the slightly undulating pampa, the moister hollows or shallow cañadas are lined with a softer turf, and denser swards mixed with various low, succulent plants and flowers.

The changeful albeit monotonous aspect of the pampa has been thus described: 'Coal black in spring when the old grass has been burned; bright bluish-green when the young leaves sprout; later on brownish-green, the colour of the mature grass; finally—at the flowering time—when the silvery white spikes overtop the grass, over wide tracts it seems like a rolling, waving sea of liquid silver.'

Swift animals, rheas, hares, and now horses and even cattle, roam over the pampa, which affords them a magnificent pasturage. After the wild Indians, the half-breed Gauchos, wonderful horsemen, took possession of the ground, mostly as horse-breeders. Agriculture, however, at first restricted to the moister and more fertile cañadas, has gained a firm foothold in the east, and is extending westward in limitless fields of corn, maize, flax, and alfalfa where the wild grasses once stood, so that the eastern provinces especially have now become one of the important granaries of the world, competing with Australia, Russia, and North America.

A notable fact is the invasion of the east of the country by European and more especially mediterranean weeds, which seem to push back the native herbs and find a congenial habitat: the invaders are mostly thistles and grasses. Perhaps the most striking change in the pampa is the sudden outburst of woodlands: the rich black soil has needed only ploughing and aerating to ensure the rapid growth of large plantations of various kinds of trees and of prosperous orchards of peach, plum, quince, and many other fruits, on what were twenty years ago treeless solitudes. The native Indians of the big plains were primarily nomad hunters, and knew very little of agriculture.

Uruguay and Entre Rios. The lower course of the Paraná is bordered by wide flood territories in process of building up, and presenting much the same appearance as the vast swampy country to the north. The region between the Paraná and the Uruguay, Entre Rios, forms a low tableland built up by deposits brought from inland, but already in process of erosion. On that account it assumes a slightly rolling appearance.

With a warm, temperate climate, this region also

receives a fair amount of rain throughout the year, with a marked rainy period. The landscape is essentially parklike grass-land, studded with groves of trees or small woodlands. The forest islands show a distinct mild-temperate type of medium-sized trees with small somewhat leathery leaves and dense crowns, and a thick undergrowth, from which the tropical wealth of woody lianas and the aerial gardens of broad-leaf epiphytes are absent. On grounds of more recent formation, still caked and hard, are developed thin woodlands of orchard-like aspect, with a grass carpet, and a dotting of low, thorny and bushy acacias, fine-leaved and shadeless.

More rolling and slowly rising in a regular swell towards the Brazilian uplands, Uruguay offers much the same natural features: Entre Rios is partly agricultural, while in Uruguay, the more rocky land, though not unsuited, in many places, to agriculture, has been transformed, on account of its natural pastures, into a vast cattle-ranch. With the increasing immigration of Europeans, however, the cultural resources are developing, maize and wheat being the staple crops.

Patagonia semi-desert. A truly dismal picture is that of the Patagonian semi-desert which stretches, south of the Rio Colorado, from the Atlantic to the Andes: a rolling plain of shingle, gravel, and sand, bestrewn with marshy hollows, cut up by ravines and cañons, broken occasionally by short and low ranges. The climate is half desert, but winter colds and frosts and icy winds are prominent features: rain falls only occasionally, and then in downpours. The result is a treeless, open, even scattered growth of bushes, mostly *Compositae*, *plantago*, *verbena*, &c. These shrubs, from three to nine feet in height, are scrubby, thorny, and woody, with tiny, grey, leathery leaves, all viscous or hairy. Most

of them, half-dead bundles of crowded twigs and stems, look like bristling besoms; some resemble heaths; others crawl, or spread in cushions: grass plays here but an unimportant part. Thickets of these woody perennials alternate irregularly with naked tracts, and in winter cast their scanty foliage. Here again countless marshes, mostly brackish or salt, are formed in the hollows, or by the rivers losing themselves in the sand and gravel; they allow of the usual salt-bush vegetation.

Little can be done with such a land, and it lies mostly unused and unusable: settlements may, however, be found along the coast, or along the few freshwater rivers. The intervening wastes are but travesias, where only wild Indians manage to eke out a precarious living, mostly by hunting and fishing.

South Patagonia. A region of steppe extends to the south and west of the Patagonian semi-desert, beginning in a strip along the Andes, and gradually widening to the south-east down to the Atlantic, covering the whole breadth of the low south Patagonian plateau and the north-east corner of Fuegia.

The latitude is now high, and the narrow point of the austral continent plunges into the zone of raw and moist south-westerlies. The Andes have become at once lower and more interrupted, with, as a result, a play of oceanic winds over the land, and a cool, cloudy, somewhat moist and windy climate, where winter is not extreme. The ground is the continuation of that farther north: a low plateau or high plain, undulating and broken, consisting of shingle, rubble and gravel, clay and sand. These conditions are not favourable to tree-growth; the country may be described as a vast treeless moor, offering a rough, irregular surface. Tussocks of the tussock-grass, *poa flabellata*, build huge

well-packed cushions on thick root-stooks; bog-balsam strews equally large and crowded bunches or mounds over monotonous heath moors; a number of crawling or low, evergreen, small- and hard-leaf bushes are intermingled with a few grasses.

Rougher still and more broken, rainy, chilly, and wind-swept, is the group of the Falkland Islands, with a very similar vegetation, though with quite a number of plants of its own, and one or two bushes in sheltered valleys. Here again the winds are the main cause of treelessness.

South Patagonia is suitable for sheep-farming, though most of the settlements are as yet confined to the coast and rivers.

Fuegia. The foot-hills and piedmont strip along the Andes, extending across the Straits of Magellan, over the plateaus of central Fuegia, east of the mountains, are more favourably situated than the steppe region just described, which it succeeds to the west and south. More sheltered, perhaps, yet receiving the benefit of the western rainfall through the gaps of the mountains, this region stands intermediate between the western timbered highlands and the drier eastern steppes. It also enjoys a milder and more equable temperature, but has a strongly marked winter.

It is a park landscape, the aspect of which recalls, in a measure, that of our northern countries, with thickets, woods, and even forests of middle-sized, summer-green Antarctic beeches, an undergrowth of shrubs and ferns, and a carpet of mosses and lichens. The intervening grass-land is somewhat like our wild pastures and meadows. In point of climate and vegetation it is comparable to the northern part of our own island.

The Andes. Ranging through 65 degrees of latitude,

from the hottest to the coldest, and from the most arid to the dampest regions, the cordillera of the Andes practically summarizes the vegetation of the whole world; there is scarcely a form of plant life that is not represented on that mightiest of mountain-ranges. A powerful barrier athwart the path of the winds, it is abundantly watered, now on one side, now on the other, exhibiting nearly everywhere the opposite extremes on eastern and western slopes. Under the equator, and farther north, the benefit of the rain-belt extends in fairly equal measure to both sides, so that the northern range as far south as Guayaquil is under the influence of regular and sufficient precipitations and shows no striking contrast. Farther south, down to 30° S., the eastern slopes are still well watered, though the western side experiences extreme drought; then for a short interval of about 10 degrees of latitude, under warm temperate conditions, both sides are about equally dry.

In the southern domain of the westerlies, however, the Pacific slopes become very moist, while the east remain arid, and are not admitted to a share, limited though it be, in the western rains before reaching 48° to 50° S.

Eastern Andes. The Montaña. This name may be applied to the vast crescent or amphitheatre of slopes which define the Amazon valley on the west and extend from Venezuela to the Argentine border, i.e. to the Tropics; locally it is restricted to the Peruvian and Bolivian portions.

The Amazon selva rises up the slopes, almost unchanged, to 4,000 feet or so, under the same conditions of an excessive and uniform rainfall and heat. It is followed higher up by a zone of rain-forest, with a cooler, though scarcely less rainy climate, and exhibits

smaller palms and lianas, tree-ferns, and bambus, the features of the subtropical rain-forest all over the world. This is the home of the cinchona, now cultivated in similar situations in tropical Asia, and of the wax-palms. The main body of this forest retains its character up to 7,500 feet, when it stops. Wax-palms and some hardier trees go on and up, mingling with deciduous trees to 9,000 or 10,000 feet. In the next zone, the woodlands display low trees of 'rose of the Andes', *bejaria*, and numerous tall shrubs of *escallonia*, *drimys*, *buddleia* (whose vegetation recalls that of the larger kinds of rhododendrons), and an isolated conifer, *podocarpus*. This woodland zone reaches up to 10,500 or 11,000 feet. The upper belt includes the paramos and higher slopes, treeless and reduced to a brush of bushes and grass, with carpets of dry, woolly alpine plants.

Argentine subtropical Andes. From 20° to 25° S., the eastern Andes establish a transition to the drier conditions prevailing farther south. A cross-section of these slopes offers a lower or basal strip of forests succeeding to the park landscape already mentioned, with its dry and interrupted woodlands which begin at few miles from the sierra. As might be expected, the lower slopes of the mountains are moister than the adjacent plains. Stately trees with dense crowns, including machoeriums, laurels, chestnuts, and broad-leaved cedars, and a rich undergrowth, compose these virgin subtropical rain-forests. They are extremely valuable for their timber, and the nature of the climate, highly favourable for all subtropical produce, would lend itself to a prosperous agriculture were it not for the difficulty of communication.

A quite temperate zone follows above 3,000 feet,

exhibiting forests of the *podocarpus*, along with Peruvian alders, elders, escallonias, &c. The mountain is no longer clad with an uninterrupted forest, but rather displays a park landscape where woodlands prefer the shelter of valleys, and grass and bushlands cloak the ridges. With increasing altitude the proportion of grass-land rises, and soon comes a belt of pastures with grasses three feet high, interspersed with clumps or isolated specimens of the stout and gnarled queñoa-trees, barely twenty feet high, which are hung with draperies of tillandsias. Above 12,000 feet even the queñoa ceases, and alpine pastures develop with the usual aspect, rich in flowers, until the snow-line is reached.

Continuing along the eastern slopes of the Andes, there follows a truly arid strip extending far southward. This district, like some others, has known prosperous times, when nearly every valley had its lake and its area of cultivation, and supported a fairly large population with a comparatively high degree of civilization. Whether by natural or human causes, or the combination of both, this state of things ceased to be soon after the invasion of Europeans.

Dry Argentine Cordillera. A cross-section of these slopes would show nowhere forests or even a parklike landscape. Succeeding to the chañar or espinal vegetation comes first, on the lower slopes and foot-hills, a belt of scattered scrub or chaparral, a dreary rocky landscape where grass is scarce and parched. This subandine belt, entirely useless, is dotted with thickets of creosote and low acaceous bushes, but farther up, the bare ridges are seamed with gorges, in the shelter of which meagre woods and patches of the leguminous adesmia shrubs, *leña amarilla*, are conspicuous on the naked slopes. Still lower and more scattered bushes occur above that

belt, and lead up to an alpine zone of dwarf crawling perennials, only scattered on shingles, but more densely grouped on peaty tracts. This landscape continues till the extreme south of Patagonia is reached, when another more cheerful aspect replaces it. It is a transition from the western timbered Andes to the dry steppes of the eastern plain—a park landscape where the trees are deciduous. This dry portion of the Argentine cordillera is useless to man: it is condemned to remain unused and barren, but the south Patagonian slopes may some day lend themselves to pastoral industries.

Western Andes. Of the equatorial and Colombian portions a brief mention has already been made (p. 131).

Peruvian Andes. The Peruvian Andes have been divided into a lower belt, the 'cuesta' or coast, and an upper belt, the 'sierra', or mountain. The cuesta is rainless and hot, with frequent dew and mists at night, and except for a narrow, sandy coastal strip, it is waste, rocky, and hilly, and barely supports a scattered thorny brush of mesquites and acacias, studded with cerei, opuntias, and cacti, where occasional showers give rise to an ephemeral crop of brightly flowered herbs. The narrow, extremely arid coastal plain is crossed by numerous short, snow-fed mountain streams, the lower valleys of which run as parallel oases, each a small Egypt between the intervening wastes. Each valley possesses its little town, with sometimes a port at its mouth.

Above the coast-belt rises the cordillera or sierra belt from 7,000 to 12,000 feet, frequently wrapped in clouds, and for that reason cooler and moister, with also a somewhat denser covering of evergreen shrubs and shrubby perennials. To this zone we owe some of our garden plants, amongst them, varieties of calceolarias, lupins, clematis, echeverias, and tobaccos. It gradually



Fig. 54. Cactus on the dry slopes of the Andes.

passes to the alpine belt of sparsely dotted dry, dwarf plants.

The Peruvian Andes was once the seat of a powerful and advanced civilization which flourished until the Spanish conquests of the sixteenth century; now impressive ruins are the only traces to be found. Agriculture, with irrigation and manuring, was then brought to a point of perfection which has not been equalled since in that region; but large areas which had been under cultivation now lie desolate, claimed by the desert. The prosperous cities which lined the shore, nestled in the valleys, or expanded on the plateaus, have fallen into ruins. There is no doubt that in the times of the Incas, Quichuas and Aymaras, before the advent of Europeans, the belts of vegetation and cultivation were broader on the Pacific slopes than they are now, which may be due either to better climatic conditions or to artificial irrigation, or to both.

Atacama. About the latitude of 20° S., the rapid declivities of the coastal ranges give way to a succession of broad terraces broken by ranges and rising in steps towards the top plateaus of Bolivia. This region is practically an absolute desert the soil of which is impregnated and covered with alkalis, perhaps the barest place of the tropical world. Human habitations are entirely confined to the coast, where water can be had by boring, and a few straggling trees and sage-bushes and mesquites are occasionally met with. From terrace to terrace, and up the naked scarps, the desert rises to above 10,000 feet, only to merge into the scarcely less dreary inland punas. Yet it is from those very deserts that one of the most valuable fertilizers—nitrates—is extracted and shipped to the whole world.

Central Chile. By Caldera, the desert proper stops,

and by a gradual diminution of aridity passes to more prosperous landscapes.

Situated between a coastal range and a mountainous background, the central valley of Chile is almost an exact replica of the Sacramento valley of California, and, like it, frankly mediterranean in character. The valley itself has a grassy floor with a thorny brush, mostly evergreen, of mimosas, colletias, &c., recalling the chaparral and the maquis. It is now being thrown open to the cultivation of mediterranean produce, thanks to irrigation. Farther inland the slopes are clothed with a taller woodland of hard- and small-leaf shrubs like *quillaja*, *saponaria*, *sumac*, and *escallonia*, which strikingly resemble evergreen oaks and other mediterranean evergreens. Above this belt of woods the evergreen beeches, corresponding to ilexes, make their appearance in regular forests. Araucarias replace the pines of California; tubers and bulbs are marked features of the vegetation.

South Chilian Rain-forests. A little to the north of Valdivia, by 36° S., begins the forest-region of Chile, with the predominance of the austral moist, westerly winds, which produce an equable, very rainy climate, warm temperate in the north, cool in the south. The whole country then becomes abundantly timbered up to the tree-line. The lower belt represents a true temperate mixed rain-forest, dark and dense, composed of several evergreen small- and hard-leaf beeches mingled with leaf-shedding trees of the same genus, a wealth of climbers and epiphytes, bambus and tree-ferns, and of smaller trees like the magnolaceous *drimys Winteri* and several other kinds, among which are conifers. Above 5,000 feet the forest passes to the shrub-woodland of dwarf deciduous beeches. This belt again gives way, at about 6,000 feet, to a bush-land of barberry, cran-

berry, escallonias, and other shrubs. The upper alpine belt consists of perennial herbs scattered on gravel and rocks.

Extreme South and Fuegia. The forest region continues uninterruptedly down to the extreme point of Fuegia, on the western slopes, and though retaining its evergreen character in spite of the high latitude, it becomes poorer and poorer both in size and variety. The same small-leaf green beeches spread to the farthest south with the drimys tree, but tree-ferns, lianas, epiphytes, and bambus disappear, and with them the warm-temperate luxuriance. Now the forests are dark and damp, somewhat resembling our spruce forests, and under their heavy canopy there is only a thick litter of rotten wood, with a soaked carpet of mosses and liverworts, some ferns, and a scanty undergrowth. Like the preceding, the south Chilian region remains an important timber asset, but on account of the steep and broken nature of the ground cannot be put to other uses.

Punas. The higher plateaus that stretch between the cordilleras of the Andes, with their abrupt and extreme alternations of heat and cold, their scanty rainfall, and their dry, icy winds, receive the name of 'punas'. They are vast wastes of rocks and salt, the worst types of which are absolutely bare, while others are strewn with the 'ichu' feather-grass in dry, bristling tufts: bulbs, rosette- and cushion-plants, and alpine bushes are also characteristic. Some punas at a lower level, like that of Jujuy in Argentine, are treeless grass-lands of a dry, yet more prosperous and useful, description.

The punas are very thinly inhabited, for vast tracts are wholly desert. They cannot be utilized for agriculture, or even for grazing purposes to any large extent, except in some sheltered corners. The native camel, the llama, alone finds a scanty food, and it is used as a pack animal.

CHAPTER IV

AUSTRALIA

LYING across the tropic of Capricorn, the vast Australian mass of land is primarily divided into an intra-tropical and an extra-tropical portion; but this distinction is mostly felt along the margins of the continent, and the desert centre varies little from south to north. On nearly all sides the margins are higher than the interior, and, forming barriers which lie athwart the paths of the winds rushing in from the surrounding seas, rob them of most of their moisture, leaving the centre almost rainless. Broadly speaking, Australia may be described as a desert with a fringe of vegetation; but whereas in the northern half the rainfall, which is of the monsoon type occurs in summer, the extra-tropical portion depends for its water mainly on the westerly storms of the austral seas which, in winter, reach the two southern points of the continent. Only the middle of the east coast enjoys the benefit of the south-eastern trade winds. Australia does not reach latitudes high enough to experience any severe cold. The snows which occasionally cover the loftier parts of the southern highlands are never of long duration.

Northern Point of the Tableland. The northernmost point of the continent is little known as yet. Along the shores of the warm seas it enjoys a wet period of five months' duration and a yearly average precipitation of 65 inches. A few tracts of luxuriant tropical forests are known, but it is uncertain if they are merely of

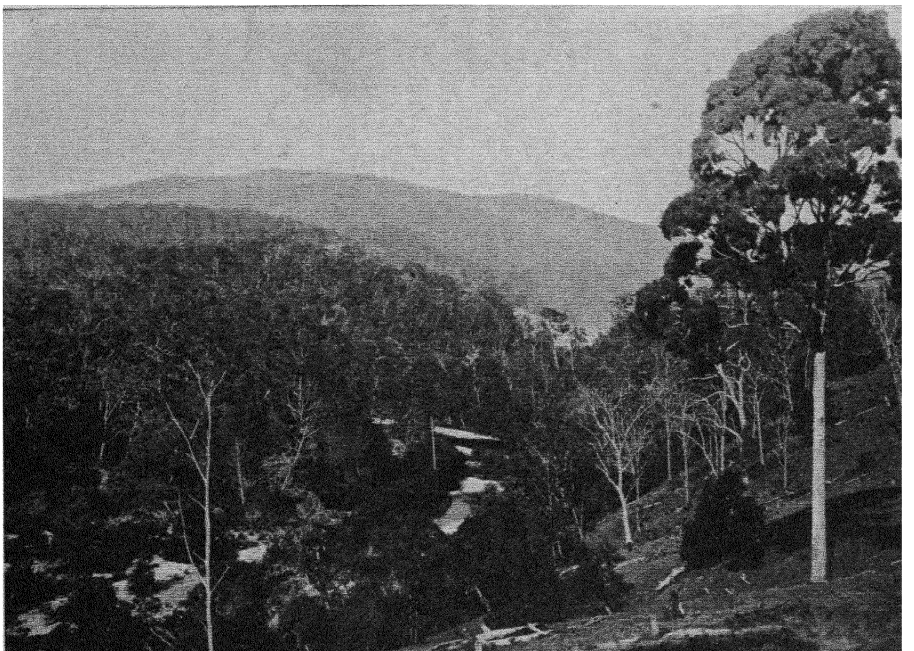


FIG. 55. A Eucalyptus-clad gorge in the mountains—N.E. Australia.

local occurrence. The prevailing vegetation is of a somewhat dry type, rather of the nature of a light monsoon forest passing to the thornwood. Tropical plants like the *pandanus* and a number of palms of the Indo-Malayan region are undoubtedly present, with one

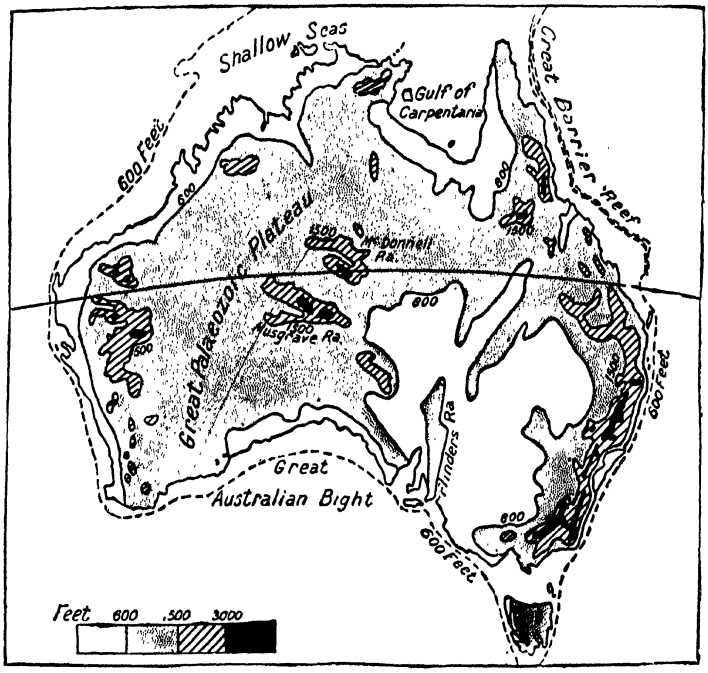


Fig. 56. Physical features of Australia.

or two large tropical species of leguminous and other trees; mangroves are frequent along the coast.

Except for a few settlements of white men dotted about the shore, the country is left to the primitive Australians; but it is destined by its climate and soil to enjoy a prosperous future.

The adjacent islands are fairly well wooded.

Thornwood. In the rear of this first belt, from the south of the Gulf of Carpentaria to Victoria River on the west, stretches a somewhat hilly zone of very light tropical woods casting their foliage during the dry period and resembling the caatinga of the Brazilian sertão or the rain-green woods of the East African

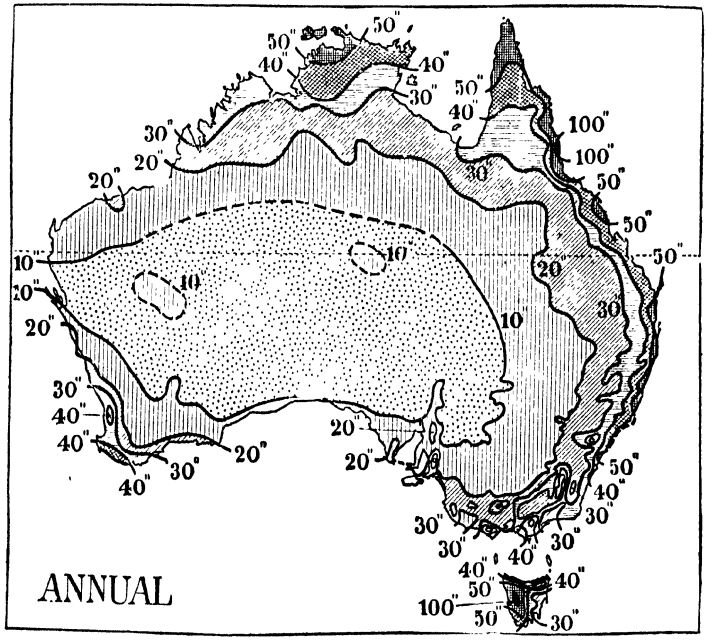


Fig. 57. Mean Annual Rainfall of Australia, in inches.

plateaus. Acacias play here quite a predominant part, with eucalypti of moderate height, melaleucas and the Australian tea-trees.

Tropical Savana. The light rain-green woods of the north thin out farther inland; the precipitations also fall below an annual 40 inches and display great fluctuations from year to year. Then comes the savana,



FIG. 58. Savana landscape with **nucleus of a settlement—Australia.**

stretching in a belt from Dampierland to the north-eastern highlands, alike on the western plateau and in the central lowlands, over the large levels broken by short ranges of hills of the former, and over a flat or undulating territory farther east.

In its general aspect, the savana is a brush of tall tuft-grass, dotted with groves or solitary specimens of

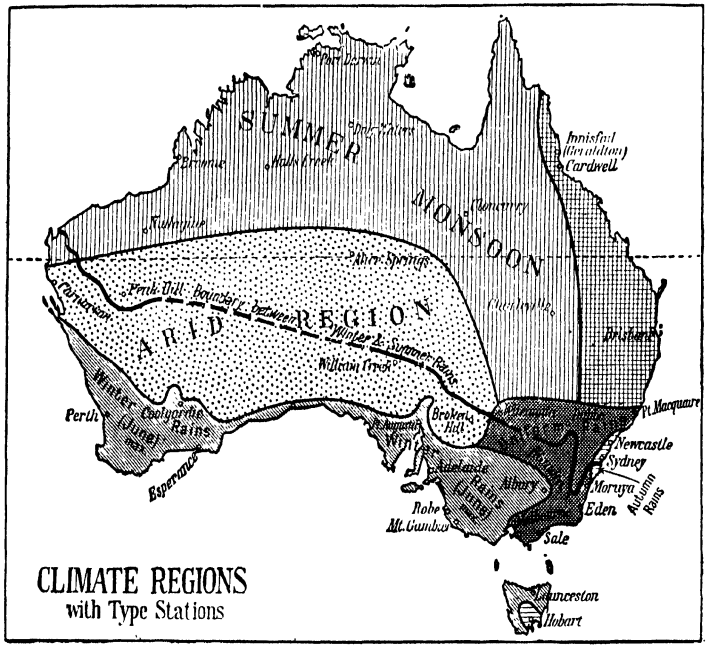
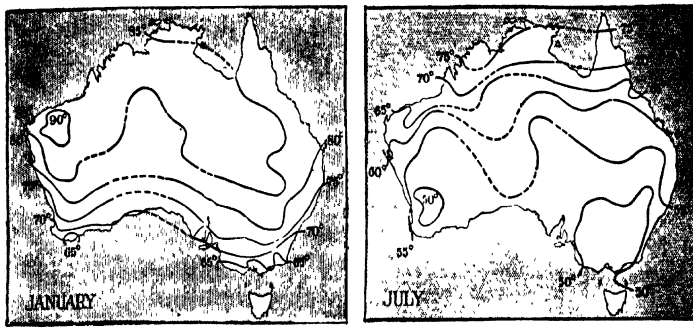


Fig. 59. Seasonal distribution of Rainfall in Australia.

low shrubby trees, mostly evergreen like eucalyptus, or heath-like (casuarinas), or again with thickets of acacias. The most important trees of this savana are again the melaleucas and the tea-trees. As in Africa and America, the bombax tree is conspicuous. This belt is frequently interrupted by tracts of scrub, and in



FIGS. 60 and 61. Mean Temperature of Australia reduced to sea-level.

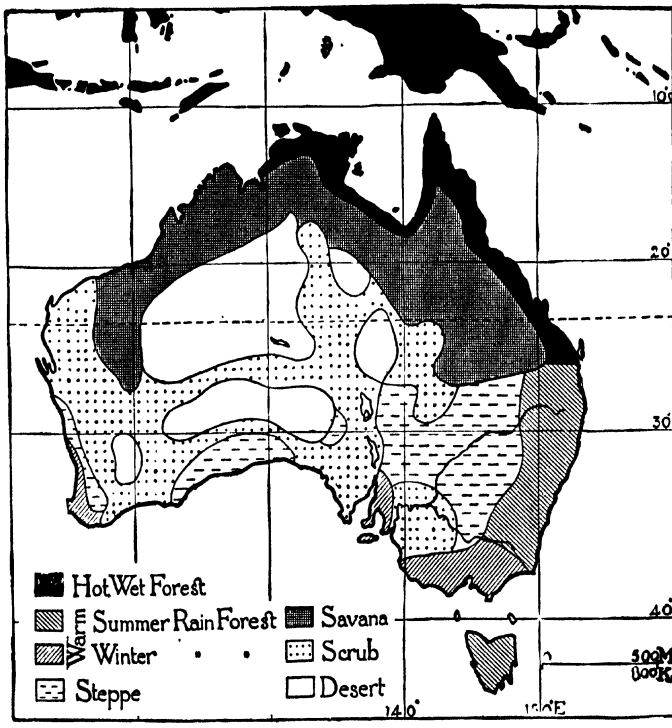


FIG. 62. Vegetation of Australia.

Queensland, west of the mountains, it is especially claimed by the Brigalow-scrub, consisting of acacias. Towards the south, the savana passes gradually into desert through a belt of acacias, by the disappearance of the grass and the scattering of the shrubs.

Scrubland. Between the wooded areas of the coastal margins and the inland desert there must, of necessity, extend a transition belt, where the rainfall is not abundant enough to support a continuous and dense tree-growth, while, on the other hand, the irregularity and distribution of the precipitation are not favourable enough for the development of large grass carpets. This belt, if we recall what occurs on other continents, is likely to be characterized by a scattered vegetation of evergreen shrubs with a scanty admixture of grass.

Three main types of scrub have been distinguished, each with a specific appearance. They are all restricted to belts which have a yearly rainfall of under 30 inches. Of the three main types, two, viz. the 'Brigalow' and the 'Mallee' scrub, appear to require at least 15 inches of yearly precipitation, whilst the third, the 'Mulga', in its poorer forms, seems to be able to stand extremely arid conditions, and therefore penetrates far into and among the true deserts. The respective relations of the three types with their physical conditions have not as yet been properly worked out, though the Brigalow scrub is a specific characteristic of the hot, tropical conditions of northern and north-eastern Australia, while the Mallee characterizes the warm-temperate climate of the southern and south-western parts.

The Brigalow Scrub is best represented in Queensland behind the coastal range and south of the Gulf of Carpentaria, amid climatic conditions which recall those of the drier parts of the Brazilian sertão and the portion

of the Egyptian Sudan extending at the foot of Abyssinia. Accordingly, its appearance and mode of life offer a striking resemblance to the thorn-bushes of those regions.

The scrub derives its name from its chief component, the Brigalow acacia, a shrub or small tree with hard, grey, sickle-shaped leaves, and makes a true acacia thornwood. Apart from this, which is very intolerant of other trees, there are two trees of the same family, and a few other tall shrubs, the most characteristic of which is the sandal-wood or dog-wood. The smaller plants and woody perennials gather round the centres formed by the tall shrubs, and often make up impenetrable thickets. Grass is very scanty, but herbs with bright flowers—the African marigold and the scarlet pimelea—relieve with their gaudy colours the prevailing shimmering silvery-grey tone.

The thornwood becomes more scattered towards the dry interior, and passes into an acacia semi-desert, but towards the east, and on moister soils, it invades the savana and passes to a park-prairie with grass-glades. The scrub and the grass, however, never intermingle. The thorny bush advances in the midst of the swards with an unbroken, impenetrable front, and, untouched by cattle or sheep, slowly claims the grass expanses which have been exhausted by excessive grazing.

The Mallee Scrub belongs to the half-arid interior of the southern and south-western portions of Australia, in a warm temperate climate. The impression given by a Mallee landscape is one of extreme monotony: 'A boundless, waving sea of yellowish-brown bushes. In the far distance is the blue outline of an isolated hill or a granite top. Otherwise the uniform dark-brown circle of the horizon remains unbroken, silent and motion-

less, except for the plaintive cry of the scrub fowl or the rustle of the dry twigs stirred by a puff of wind.' This scrub is composed, in the main, of three or four bushy forms of eucalyptus, crowded together. Each shrub consists of a close crop or bundle of long, thin shoots, of the height of a man, ending in bunches of long dull-green, leathery leaves. A small conifer, *callitris*, occurs occasionally in the bush: elsewhere, the strange melaleucas, the leafless casuarinas, and a few others with heath-like or vertical leaves, appear where the scrub opens. There is no grass, and hardly any flowers on the bare, yellow or rust-coloured soil. Seasons may pass without altering the aspect of the Mallee, to which no exact analogue is known in any part of the world.

The Mulga appears to correspond in some measure to the acacia semi-desert of Africa; but its aspect is more varied, its definition more vague than that of either the Brigalow or the Mallee. The name is probably applied to the semi-desert scrub which borders on the desert and penetrates into it. Thus the western margin of the great plateau with a rainfall under 10 inches, the eastern foot of the same tableland from south to north, and the strip of higher ground with hill-ranges that separate the great sandy desert on the north from the great Victoria desert on the south and enclose many tracts of pure desert, appear to answer to the description of the Mulga territory.

Mulga appears to be made up of a scattered scrub of thorny acacias, with a ragged carpet of grass. Sometimes it is said to crowd into dense thickets; sometimes it resembles a low meagre sward studded with bush acacias: in this form it is the equivalent of the marginal vegetation of the Sudanese Sahara; sometimes it occurs as oases in the desert. Among the good fodder-grasses

available there are reckoned several species of those kinds of *andropogon*, *aristida*, *stipa*, &c., which occur also in arid parts of Africa and America: others, like the kangaroo grass and the porcupine grass, are restricted to Australia. The typical desert grass is the *spinifex*, whose little balls of long, narrow, hairy leaves are anchored in the sand by means of a network of long,



FIG. 63. A station in the Savana Country, N. Australia. Note the grass trees.

thin, wiry roots. This scrub may ultimately be reduced to a thin carpet of flowering herbs, with little grass.

The large alkali tracts of the central lowlands, as in other arid countries, are covered with juicy and fleshy salt bushes. In the north the swamps are beset by relatives of the spinach, the *rhagodia*, and, *mühlenbeckia*. These salt steppes provide a good feeding for sheep and cattle.

Some forms of what is here included under Mulga are not entirely without economic use. They may serve as grazing grounds during the rainy years, but the fluctuations of the precipitation render their pasturage precarious and temporary.

Great Central Desert. This covers the largest part of the western tableland and portions of the central lowland, and is split into a number of minor areas like the Great Sandy Desert, the Gibson Desert, the Victoria Desert, and others. Beyond the fact that it contains no grass other than solitary tufts of *triodia* and *spinifex* and, occasionally, shrubs of *acacia* and *casuarina* which correspond to the gum acacias and the tamarisks of the Sahara, little is known of its specific vegetation. It has no oases, properly speaking, but only approximations to them in the shape of patches of Mulga. However, there is a 'Glen of Palms' on the north slope of Macdonnell Range.

Murray-Darling Valley and South Australia. At the back of the south-eastern highlands the plains are clothed with a grass-land of a warm temperate type, the surface of which is sprinkled over with trees and shrubs—a park landscape resembling some formations of southern Rhodesia or of southern Brazil and Uruguay. A similar park grass-land of a warm temperate stamp existed at one time along the coast of South Australia, but it has been largely transformed for agricultural purposes.

Here again eucalyptus, acacias, mimosas, and other brightly flowering trees and shrubs compose the higher vegetation, while among the short grasses are interspersed a large number of beautiful herbs, which burst into flower at the beginning of the rainy season in winter: the summer is parched and scorching. One

encounters here an approximation to the condition of the mediterranean climates; and this is increasingly the case as one travels farther south.

These lands within the belts of 20 inches of rainfall should form excellent wheat and maize territories, but a large part of them also affords a vast scope to pastoral industries.



FIG. 64. Savana landscape in East Australia.

Mediterranean Portions of Southern Australia. The belt of westerly storms of the austral ocean advances northwards in winter and reaches the two southern extensions of Australia, creating a climate almost exactly similar to that of the Mediterranean. Accordingly, the vegetation of south-western Australia and that of South Victoria is in many respects a replica of that of the Mediterranean, of central Chile, and of California. Its

most luxuriant expression is found along the south-western shore of Australia, in majestic evergreen forests



Fig. 65. Gum-tree or Eucalyptus Forest in Australia.

of tall eucalyptus, with an abundant undergrowth of hard-leaved shrubs, but practically no grass carpet. It is extremely rich in remarkable shrubs with beautiful

flowers. Here is the home of these gorgeous shrubs—acacias, mimosas, proteas, banksias, and heath-like *Epacridaceae*—which are now cultivated along the Mediterranean and provide us with flowers in mid-winter. At the back of this belt the rainfall diminishes very rapidly, and the scrub, mainly of the Mallee type, interspersed with grass-lands, forms an intermediate zone leading to the inland Mulga.

Along the shores of the Spencer Gulf, the forest form is much less developed, but the undergrowth of hard-leaved shrubs builds extensive scrub which exactly corresponds to the Californian chaparral and to the Mediterranean and South African maquis. These formations, which are sometimes termed sand-heaths, are frequently interrupted by tracts of Mallee.

It was to be expected that there should be a free interchange of natural products between countries so similar as this and the Mediterranean and California. From Europe, Australia took the vine, the olive, the orange, and indeed most of its fruit-trees, while it sent back eucalyptus, acacia, and a large number of other shrubs and ornamental perennials. Quite naturally, these Australian Rivieras are developing along the same lines as the Mediterranean and Californian, with which they compete as regards the vine, orange, and other fruits.

Savana Woods. Perhaps the most extensive and the most useful plant-formation of Australia, as it is also the most characteristic, is the eucalyptus savana.

Africa has the baobab, the ceiba, and the borassus palm, and many leaf-shedding trees in its savanas; South America possesses also savana woods of the deciduous type; but Australia possesses in the eucalyptus an evergreen timber-tree of the greatest beauty

and economic value. In the mediterranean coastal strip of West Australia the eucalyptus forest is, properly speaking, an evergreen woodland overtopped by eucalyptus trees; but in eastern Australia, over most of the coastal highlands as well as over a broad margin of plains on the inland side, the eucalyptus is intimately associated with the grass-land. It stands either singly

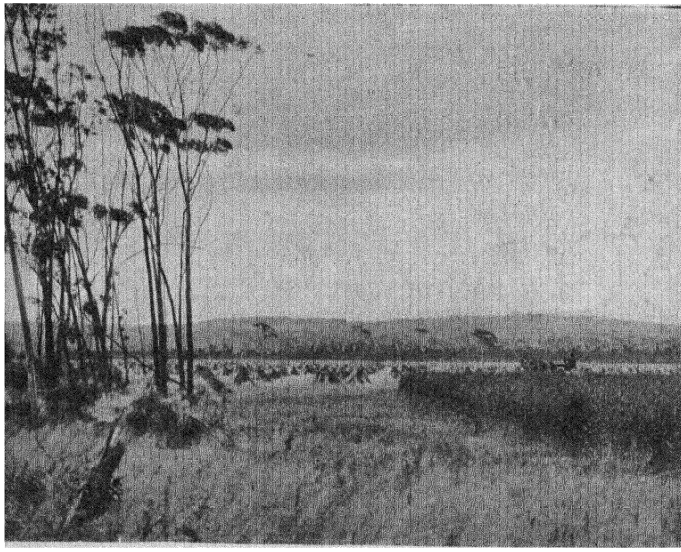


Fig. 66. Eucalyptus forest cleared for wheat: harvest time—S. Australia.

or in loose forests: when single, it is regularly dotted over the grassy plain without undergrowth, and casts hardly any shade by reason of the vertical drooping of its scythe-like leaves: when it occurs in regular forests, as in the mountains, it may be entirely destitute of any undergrowth other than grass, or possess a sort of scrubby underwood of evergreens. The forests are

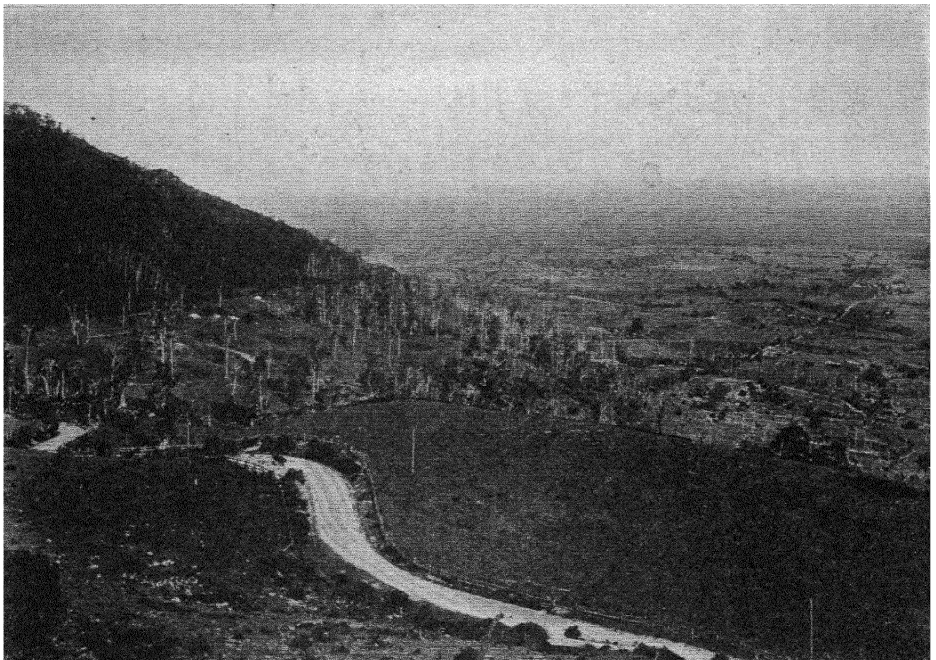


FIG. 67. Savana plain and timbered slopes—E. Australia.

always loose, and extremely clear, and the trees reach huge dimensions, rising sometimes to 300–400 feet, furnishing an excellent timber. The strong tap-root is able to reach the ground-water at great depths. They may be truly represented as the most useful trees of Australia.

From tropical Queensland to New South Wales the land covered by savana woods is extremely favourable to agriculture, and the range of produce that can be raised with success is enormous, including sugar-cane, cotton, pine apple, mango, and other equatorial produce, as well as mediterranean, and even northern crops and fruits in the south. The eucalyptus savana is equally favourable to grazing and derived industries. The belt characterized by it, on account of its extent and fertility, may be said to be the greatest agricultural asset of Australia.

South-eastern Temperate Rain-forest. The seaward slopes of the eastern highlands, south of the tropics to Cape Moore, receive rain fairly regularly throughout the year, and enjoy a mild, moist, and equable climate, which determines the development of temperate rain-forests. This hilly coastal strip is soon followed inland by the mountain ranges.

The Australian temperate rain-forest has a physiognomy of its own, distinct from that of any other in the world. This is due again to the presence of the colossal gum-trees, 300–400 feet high, which compose an irregular and light canopy, far above the lower tier. The latter which resembles the rain-forest proper, is characterized by an abundance of graceful tree-ferns, the cyatheas, alsophilas, dicksonias, and todeas, of arboreal *compositae*, acacias, and *proteaceae*, together with large climbing ferns and grasses, while the undergrowth is

crowded with ferns. In the valleys, the second tier consists almost exclusively of those tree- and herb-ferns which have given the name to the famous fern-gullies of south-eastern Australia.

The orange and vine, and cereals, chiefly maize, are grown, and dairy farming, and many other such industries, give an unlimited scope to the agriculture of this wealthy territory.

Northern Portion of the Eastern Highlands. Within the tropics, the eastern part of the Queensland highlands receives the benefit of the south-east trades and of the summer monsoon, but it is only along narrow and short strips here and there that the rainfall is sufficient to support the true selva or rain-forest. The general vegetation is of that lighter type of tropical forest called 'jungle' in India and 'bush' in Australia. The eucalypti, acacias, and banksias play here quite a secondary part in the vegetation: they are replaced by true tropical species allied to those of the Indo-Malayan flora; among them is found a stinging-tree or tree-nettle. Near the tropic appear several kinds of araucarias, one of which gives an edible nut. As may be expected, all tropical produce can be freely grown here.

Tasmania consists of a high tableland about 3,000 feet in elevation, rising and falling in step-like terraces, and surrounded by a broken and difficult hill-land. The whole island is fairly well watered, especially in the west, and its climate is mild. The central plateau is a grass-land of park-like aspect, while the mountain girdle is clad with forests similar to those of south-eastern Australia, where the giant eucalypti and the tree-ferns are most conspicuous. In the west and south, evergreen beeches and conifers, mostly peculiar to the island, impart to the forests the appearance of those

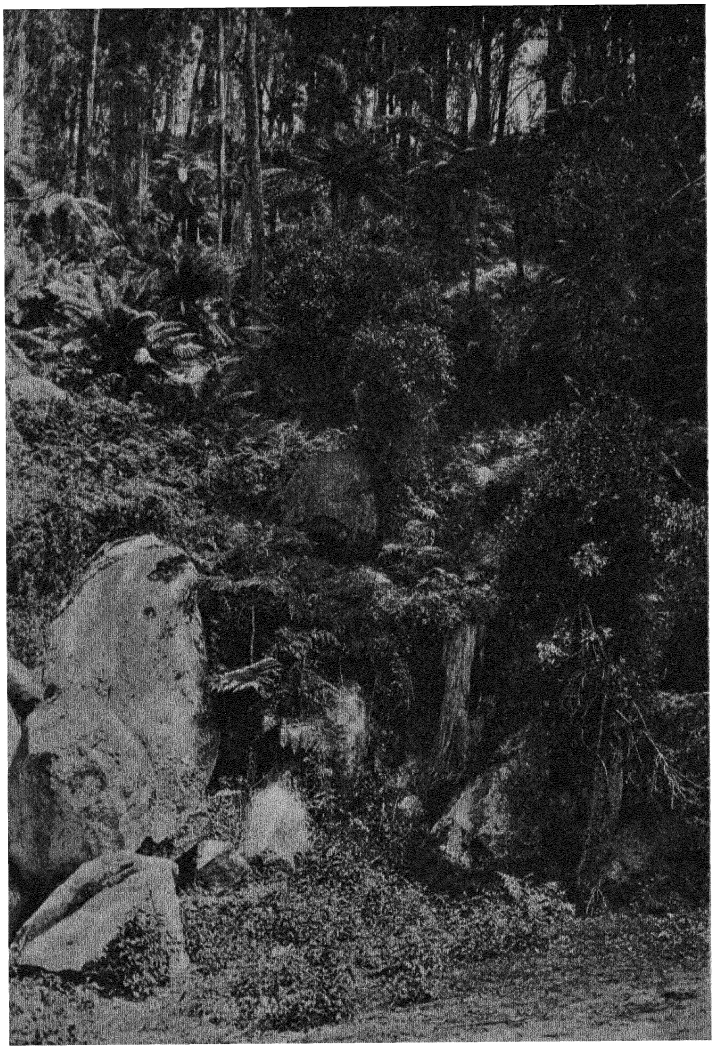


FIG. 68. Tree-ferns in a gully, Blue Mountains, S.E. Australia.

of southern Chile and southern New Zealand. The central grassy plateau is naturally mainly pastoral, while agriculture finds very favourable conditions in the valleys, and lumbering on the slopes.

New Guinea is completely equatorial in its climate. The interior is as yet practically unknown, but it appears to be entirely wooded. The northern portion, separated from the south by a high mountain-range, supports the densest type of tropical rain-forest, while in the south, which is somewhat drier, the selva proper appears to be confined to the river margins, a lighter forest or jungle occupying the intervening lands. It is also known that typical savanas, with eucalypti recalling those of Australia, are found inland about 1,200 to 1,500 feet on the southern side.

New Caledonia, parallel to the coastal range of Queensland, and situated on the margin of the tropical belt, within the trade-wind belt, enjoys a healthy, equable, and relatively dry climate. Broadly speaking, it is divided by a long inland chain of mountains and high plateaus into a moister eastern and a drier western portion. The coastal strip of lowlands, up to 1,000 feet, recalls the semi-arid belt of northern Australia, with a vegetation of savanas and a peculiar kind of woodland, with scattered, stunted melaleucas, small trees 40 feet high, arising out of an entirely bare ground. Only the river margins possess parallel bands of tropical forest. The slopes from 1,000 to 3,000 feet are more regularly timbered except on the ridges, and their forests greatly resemble the rain-forests of south-eastern Australia. The upper forest belt displays a great wealth of conifers, including araucarias and ferns. The dry, stony plateaus are covered with a short evergreen scrub. The variety of the vegetation and of the resources in

timber, pastures, and agricultural land, and the pleasantness of the climate, make New Caledonia a little independent world capable of the highest development, like New Zealand and Tasmania.

New Zealand is entirely situated in the temperate latitudes, corresponding to those of southern Europe, and enjoys, on the whole, a very mild equable climate.

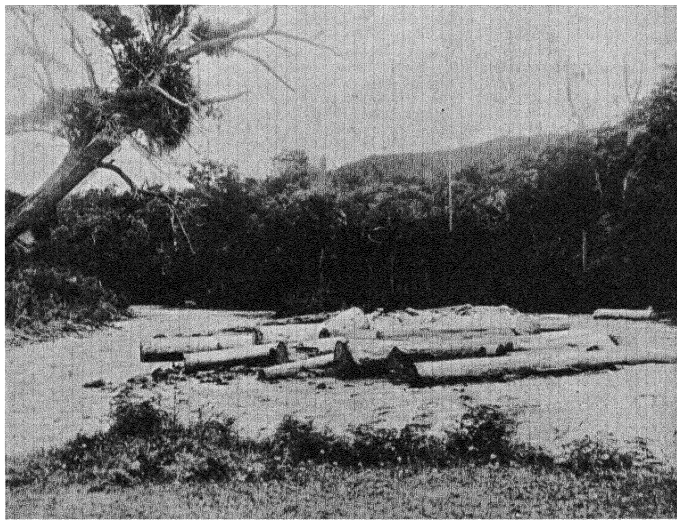


Fig. 69. Kauri Logs and Forest, N. Zealand.

Only the upper reaches of the southern Alps rise to the cold belt and possess permanent glaciers.

The distribution of the rainfall over the North Island and the northern point of South Island is fairly uniform and abundant throughout the year. This combination of an equable and mild climate with a plentiful moisture is ideal for the development of the temperate rain-forest, which finds here a luxuriant expression. One or two

species of the smaller palms give a touch of the sub-tropics, while the wealth of tree-ferns recalls south-eastern Australia. Stately conifers, however, of species entirely confined to this region—the kauri (*dammara*), the kahikatea (*podocarpus*), &c., among them—give the temperate stamp to the 'Bush'. There are many other huge trees, most of them with leathery, oval leaves. The extreme luxuriance of the forest is due to countless ferns, mosses, and lichens, &c., climbers, creepers, and shrubs, which make progress almost impossible. A specific feature is the absence of bright flowers.

Towards the south, the small-leaved evergreen beech (called 'black birch') becomes increasingly abundant, and the forest loses much of its profusion, assuming the aspect of the south Chilian beech forest. The evergreen beech only covers the western slopes of the southern Alps. On the opposite side of the range, the rainfall has decreased to 30–40 inches, and the forest remains confined, in an impoverished condition, to the moister gullies. The undulating plain which extends at the foot of the Alps, in spite of a fair rainfall, is so swept by winds as to become comparatively dry. Tree-growth is scattered and low. The plain is covered with a sort of park-prairie or park-steppe, excellent alike for grazing and agriculture: here is the home of the New Zealand flax.

The natural resources of New Zealand are varied and abundant. The timber is extremely valuable and plentiful yet, despite its rapid destruction. Agriculture and grazing are very prosperous. Subtropical and mediterranean fruits, maize and hard wheat, as well as all our temperate produce, are grown in large quantities. With its healthy climate, and the influx of the white population, it has now come abreast of European communities in every respect. The natives themselves, now

fast disappearing, had reached a fair stage of civilization before the arrival of the white man.

Pacific Islands. The great bulk of the countless Pacific islands lie within the intra-tropical belt, and therefore enjoy a thoroughly equable, warm, and rainy climate, the outcome of which is a luxuriant forest growth. Palms constitute one of the most common



FIG. 70. Pineapple Plantation.

features of these islands. The coco-nut palm, which forms a fringe round most islands, and the sago palm are the most useful. Yams and colocasias furnish starch-containing roots. The bread-fruit tree and the banana offer an easy and abundant food. Numerous spices are also found, while cultivation can raise the whole range of tropical fruits and produce. Mangrove-swamps occur occasionally on muddy shores.

CHAPTER V

AFRICA

General. Well astride of the equator, the dark continent is the most symmetrical of the large land masses. With its centre in the belt of equatorial calms and rains, it passes through the regions of trade winds into those of tropical high pressures, clear skies, and droughts, exposing only a narrow fringe on either side to the mediterranean climates. In its broad features, African vegetation may be summarized as follows:

Mediterranean
Tropical Deserts
Tropical Savanas
Equatorial Selva
Tropical Savanas
Tropical Deserts
Mediterranean.

The symmetry of this diagram is broken by the unequal distribution of African lands in the two hemispheres. The much greater area under the northern tropic not only exposes a larger surface to drought but tends to emphasize the aridity of the climate, by a sort of cumulative effect: hence the striking disparity between the Sahara and the austral deserts. Yet that the ratios between arid and total areas on the two sides of the equator are so disproportionate is not adequately explained by a mere consideration of total surfaces. South Africa is open to the moisture-bearing winds from the boundless austral ocean, without any

interference; while the north and east of the continent is dominated by the vast mass of Eurasia from which no moisture comes. The relative lowness of most of northern Africa, as contrasted with the high elevation of the

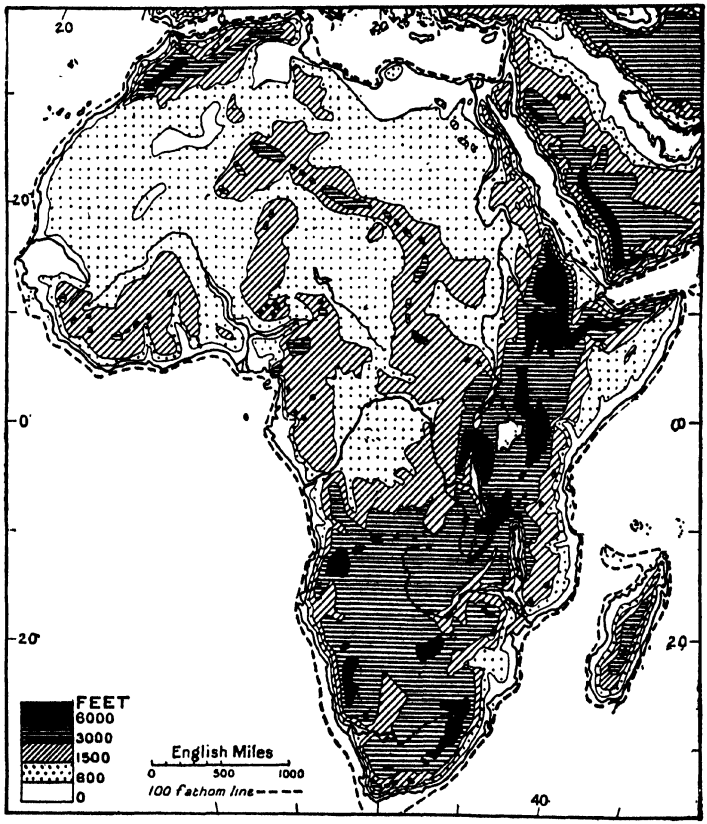


Fig. 71. Physical Features of Africa.

southern extremity, also permits much less condensation. Owing to those circumstances, in southern Africa the place of the desert is taken by a vast extent of very dry, but not desert, grass-land.

The western extension of the continent for thirty degrees of longitude under the northern tropic, the excessive heating of the atmosphere over the broiling

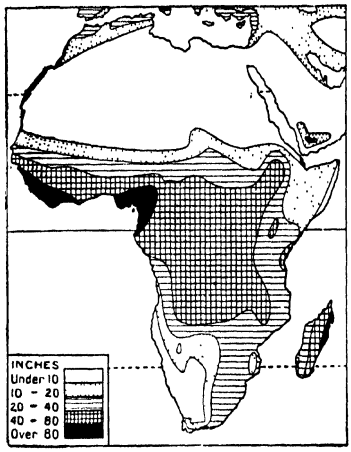


FIG. 72. Mean Annual Rainfall of Africa.

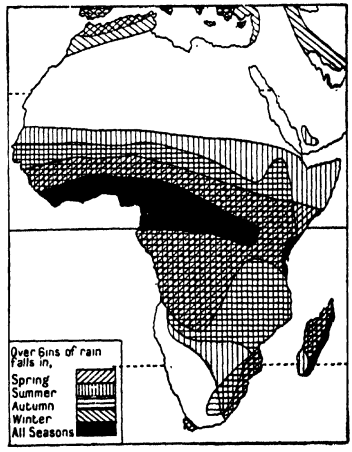


FIG. 73. Seasonal Distribution of Rainfall.

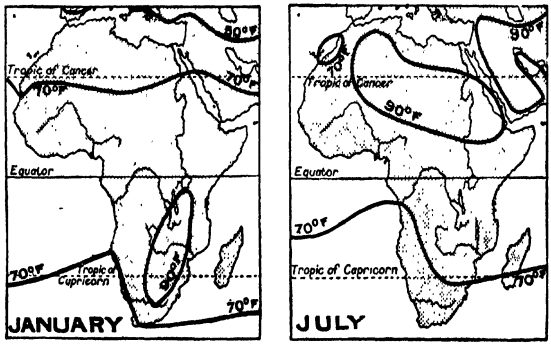


FIG. 74. Mean Temperature of Africa, reduced to sea-level.

surface of that desert, and the existence of a sufficient relief along the Guinea coast at sub-equatorial latitudes, combine to produce a partly monsoon and partly

equatorial belt of excessive moisture and the exuberant Guinea selva. The equatorial rain-forest is not carried over from shore to shore. This is to be explained by

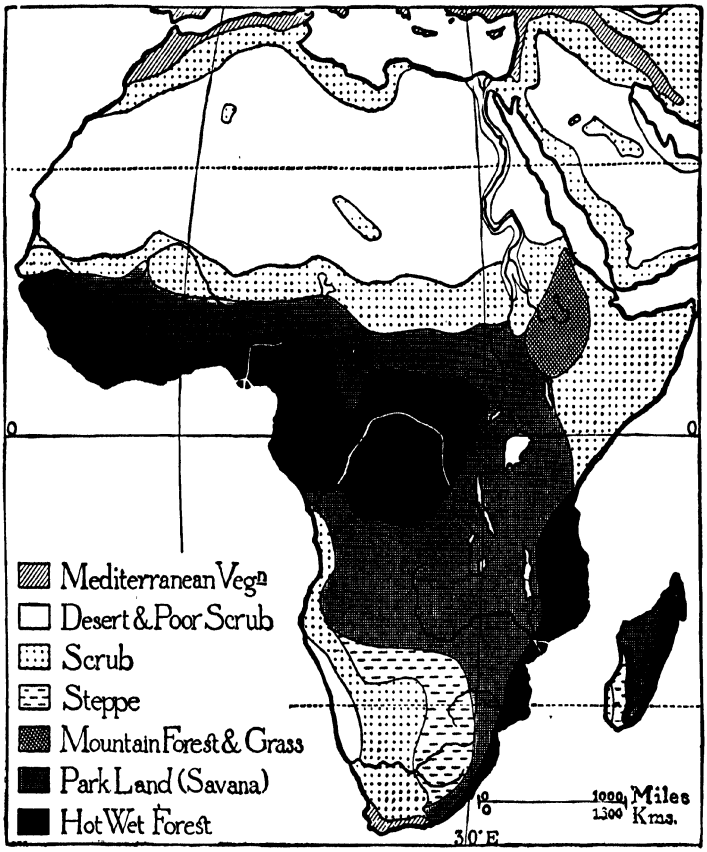


Fig. 75. Vegetation of Africa.

the absence of moist north-eastern trade winds; by the eastern equatorial portion being an elevated plateau; by the south-eastern trade winds exhausting their moisture

first on Madagascar, and the irregular mountains that skirt the eastern tableland; and by part of the monsoons being deflected and drawn towards the lofty mass of Abyssinia. As a consequence, the mountain and hill-ranges strewn over the high plains alone have sufficient moisture for the maintenance of heavy rain-forests, and these are so high that they are mountain forests rather than selvas. The undulating high plain has a savana climate and vegetation.

The elevation of the Congo basin and the barriers surrounding it reduce the rainfall, and thus the area of the selvas, which are neither so widespread nor so strongly developed as those of the Amazoni. South of them the savana covers nearly the whole breadth of austral Africa. The tropical type of grass-lands passes with higher latitudes into a subtropical, then to a temperate type. The bulk of the grass area corresponds to the trade-winds belt on the oceans, and with the elevated austral plateau on land. The sea winds spend their moisture on the eastern and southern scarps of the plateau, which are in consequence covered with a girdle of forests. The tableland has only a moderate rainfall, and the evaporation is greater.

Mediterranean Africa. The Atlas Ranges separate from Africa a strip of mountainous land, whose climate is closely related to that of central and eastern Spain. Mediterranean Africa or Mauretania, as it was formerly called, extends from Tunis to Mogador, and it includes a long and winding valley called the Tell hemmed in between a lower and much broken coastal range and the northern slopes of the Atlas. This broadens in the extreme west into fertile plains open to the Atlantic winds. On the whole, the country is fertile, and the vegetation resembles that of the mediterranean portion

of Spain. Had it been preserved in its original state, it would have been that of an open woodland and shrubland of hard-leaved evergreens where the grass is dry and wiry, finding a parallel in the valleys of California and Central Chile. Successive girdles of vegetation depend on altitude. The lowest zone consists of the coastal and western plains of the Tell valley.

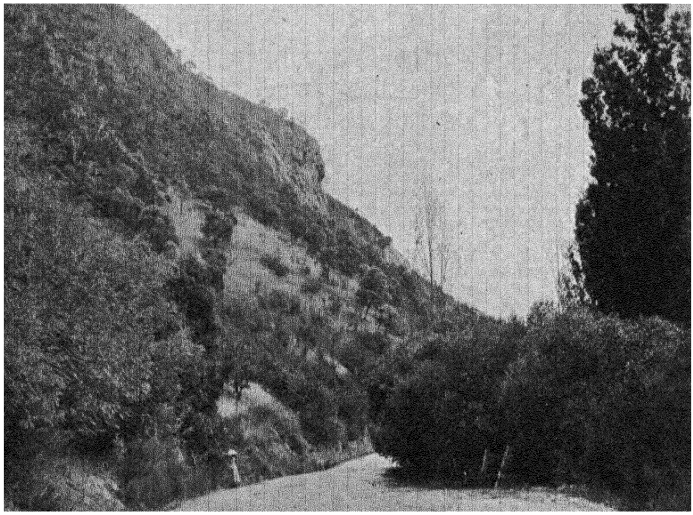


FIG. 76. Gorge in Mountains of Algeria.

This is covered with forests of Aleppo pines, cork oaks, and white or deciduous oaks, of palm groves, and olive clumps, varying with the soil. The undergrowth consists of numerous evergreen shrubs such as tree-heath, dwarf-oak, cistus, lentiscus, rosemary, &c., and still more numerous undershrubs such as thyme and lavender. The forests have now been almost entirely cleared away for agricultural purposes. In the fields are to be seen

olives, figs, date-palms, vines, and other fruit-trees; tobacco, maize, lucerne, &c. Waste lands are covered with a high and dense scrub of prickly green bushes



FIG. 77. Atlas Cedars—Algeria.

forming the maquis, or with close thickets of dwarf palms.

On the lower slopes some prosperous forests of evergreen oaks have been left. Cork oaks predominate

below, with undergrowth of myrtles, tree-heaths, strawberry trees and other shrubs, while ilex forests are more abundant farther up. Most of the original covering has long been destroyed, as in the plain, and the slopes are clad with dense scrub, when they are not entirely bare.

At about 1,600 feet, mountain vegetation, represented by the cedar of the Atlas, mingles with the holm-oak, above this the cedar forms the forest, mixed here and there with deciduous trees up to the tree limit at 5,500 feet. Loose brushes of lavender and other small bushes are scattered over the stony tops. The upper girdles have been somewhat better preserved, perhaps on account of their steeper slopes.

The variety of cultivation which is possible in this part of Africa offered great scope to the settled tribes of Kabyles and Berbers. Unfortunately pastoral and more warlike tribes conquered the land, and have held it now for centuries and kept it back. Strife between agriculturist and nomad is still rampant in the western or Moroccan region, and is a serious obstacle to its prosperity. The easternmost outlier of typical Mediterranean evergreen vegetation is found in Cyrenaica or Barka, but in a much poorer form. Mauretania, with its desirable climate and the rich rewards it offers to human industry, has at all times attracted invasions from the east. Its historical ground is bestrewn with the ruins of the Mediterranean civilizations, Greek, Phoenician, Roman, Arab, which it successively shared.

The Atlas Intermont Plateaus. Behind the great barrier of the Northern Atlas is an elevated region of vast arid plateaus, arranged in parallel terraces and dotted with innumerable salt lakes or 'shotts'. Those plateaus reappear south of the Saharan Atlas, running as a sort of shelf along the foot of the inland slopes of

the range. In this region the rainfall is greatly reduced and the climate is semi-desert, although heavy downpours may occasionally cause disastrous floods. The variations of heat and cold are necessarily greater than in the surrounding lowlands.

These high plains give us a foretaste of the great desert. At first sight there seems to be nothing but a boundless sea of scattered tufts of alfa or esparto grass over stony plateaus. Soon, however, one discovers a network of broad and winding, waterless river-beds converging towards the shallow shotts. These are marked by other steppes, covered chiefly with wormwood, in small whitish bunches. The saline tracts surrounding the shotts are laid out in belts of fleshy salt-bushes or succulents. Small dunes may interrupt these belts. They are the home of a desert-grass, the 'drinn' (*aristida pungens*), a favourite fodder of camels. Trees are absent, or confined to some isolated and thin orchards in the more fertile hollows with some ground moisture. They are reduced to the size and shape of shrubs such as the *batoum pistacio* and the thorny jujube-tree.

Amid such arid tracts, fresh-water sources and oases are welcome features. Large oases line the southern shelf of the Saharan Atlas: the largest of them, Figuig, Ain-Sefra, Laghuat, Biskra, appear like seas of waving date-palms. They are the true gates of the desert, the starting-points of those thin straggling lines of travel which span the immensity; but there are hundreds of other sources of water, in which man has bored wells. By thus tapping and utilizing the waters, he has dotted the desert with fertile orchards and gardens of fresh verdure.

As might be expected, the Saharan Atlas is much drier than the northern branch; the slopes are now

mostly bare, with blue-green patches of alfa grass, and only in the ravines and at the heads of gorges, sheltered and inaccessible, can scattered woods of green oak, Aleppo pine, and juniper be discovered: they are probably vestiges of once much more extensive forests. The high plateaus can support but temporarily the passing herds of sheep and goats, or trains of camels and horses. The esparto grass is, however, a valuable product, the collection of which occupies a few hundreds of workmen scattered in wandering communities along the railway lines.

The African Islands. The Canary Islands grouped on the west coast of the Sahara are able, by reason of their altitude, to condense a certain amount of oceanic moisture, and form a link between the Mediterranean region and the desert. The lower slopes are related with the neighbouring mainland in point of aridity. Their vegetation is of semi-desert character, consisting mainly of succulent plants. The dragon tree and the Canary date-palm are the chief trees, in addition to the olive, the Atlantic pistacia, and the Phoenician juniper. Outside the cultivated alluvial valleys, this belt offers little else than stone fields and rocks bestrewn with succulents and meagre bushes of the broom and heather type. The middle belt, from 4,000 to 7,000 feet, has open slopes clad with scrub of mediterranean character, and in the secluded gorges, temperate evergreen rain-forests have found refuge. The extension of Canary pine-forests above the preceding zone coincides with the belt of clouds and mists which frequently hide the upper slopes. More or less scattered bushes of *retama*, a kind of broom, characterize the Alpine zone, which reaches 8,500 feet.

The Canary Islands have played an important part in

the history of agriculture: a number of products of the Old World, such as the sugar-cane and the banana, only became American after a stage of acclimatization in those islands. The native populations, now wiped out, were mainly agricultural, and reached a fairly high standard of civilization.

Madeira, with very much the same plant-life, enjoys a moister climate, while, except for a few fertile spots, the Cape Verde Islands remain huge naked blocks of lava.

Sahara. Three main aspects have been distinguished in the Great Desert. They are produced not by climatic differences but by the nature of the surface.

The hamada, or rocky desert, is due to the cracking and splitting of the rocks by alternate expansions and contractions brought about by abrupt changes of temperature. It occurs as bare hills, as tablelands intersected by waterless river-beds, as undulating expanses and broken outcrops, or as isolated blocks, vestiges of the primitive surface, rising above the accumulated detritus. Low bushes are sparsely scattered on the bare floor, anchoring their roots in the fissures and cracks. Despite the scarcity of the vegetation, it is surprising to find in the hamada a large variety of species, among which are the alfa, the white artemisia, and several sage-like shrubs, or again various loose and leafless undershrubs. When the waste rocks of the ruined hamada are worn down to pebbles and gravel, or where the surface is clayey and stony, the desert is known as 'reg' or 'areg'. This gives the impression of a flat, boundless, almost plantless waste of pebbles, where sheep and camels can find practically no food. The immense barren is dotted with what at first sight appear like rounded, low, whitish boulders, but, on inspection, turn out to be extremely dense tussocks

of a cushion plant, the *anabasis*, also called 'desert cauliflower'. Such tussocks are made up of packed bundles of wiry shoots bristling with leathery, short, pointed and crowded leaves, and glued fast together by the dried clay. But for a few distant leafless bushes of *zollikoferia* and *ephedra*, two feet high, the ground seems bare as far as the horizon: on looking carefully, however, one discovers a large variety of pigmy plants.

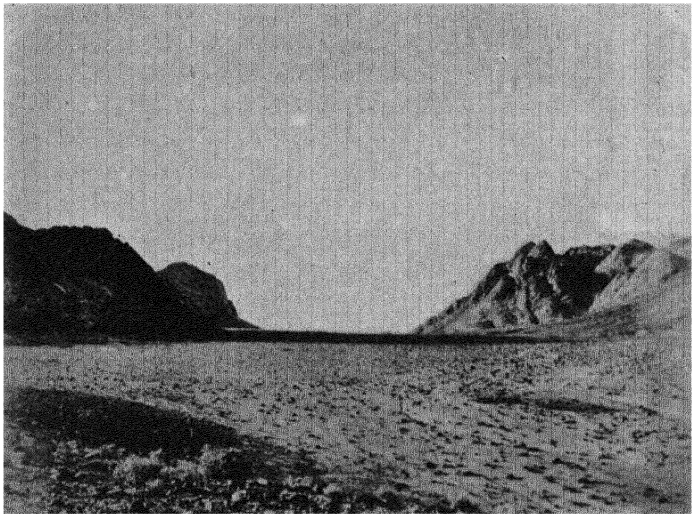


FIG. 78. Reg Desert—Sinai.[1]

Where the gravel and clay are ground to impalpable drifting sands, the formations of sand-dunes or 'erg' arise. Vast tracts of this sea of moving sand may remain entirely plantless: nothing seems to vary the beauty of the vivid orange billows; but, at other places and more frequently, the surface is sprinkled with spots

[1] Reproduced from a photograph of the Ordnance Survey by permission of the Controller of H.M. Stationery Office.

of a delicate greyish-green. Desultory bushes of leafless retama, buried and then uprooted by the wind, of Saharan broom, tufts of drinn-grass, spurge, and some other dry undershrubs and grasses are scattered over the sand. Farther on, the dunes may be partially or temporarily fixed by the binding aristida, and the tamarix endeavours to form a thin heath.

These three main varieties of the Sahara appear to be distributed in vast areas or regions which they may serve to characterize. Thus the westernmost or coastal band, including the Rio de Oro and Sahel and extending down to Senegal, is chiefly one of hamadas and aregs: a second region, stretching from Tunis to the western Aderar, includes the Great Erg, the Igidi and Elgof, and is a colossal sea of sand-dunes: to the east, a broad expanse of hamadas and aregs characterizes the somewhat higher plateaus of Ahaggar continued southward by that of Ahir; and is followed again by the somewhat interrupted and lower ergs of the Fezzan and Teda. The central portion, reaching south to the Chad and embracing the Tibu with the Tibesti range, is mostly hamada and reg. The Libyan desert, beyond the oases of Farafreh, El Khargeh, and Dakhel, is one vast unbroken stretch of dreary barren sands. In the Egyptian and Nubian deserts is shown a recurrence of the rocky and clayey, hilly type divided or interrupted by the narrow valley of the Nile or Egypt proper. Beyond the Red Sea again, the Arabian desert is divided into vast seas of moving sand and wastes of stone and lava.

The saline tracts characteristic of all deserts are always present in the Sahara, with their usual vegetation of fleshy or 'succulent' salt-bushes. As may be noticed on the maps, the caravan routes avoid the ergs and go from well to well, and from oasis to oasis, over and along

the hamadas and the regs. The oases, due to the accumulation of underground water or to the short mountain streams which lose themselves in the sands, are found in depressions or along the foot of the heights and tablelands. The well-known date-palm, which is the feature of their vegetation, is useful alike for its protection and for its products and by-products, just as the camel is valuable in so many ways. The date-palm in the oases and the camel on the road are the two essentials of desert life; and the very simple existence of the nomads and of the few settled communities is practically based on them.

Sudan Semi-Desert. The transition from the desert to the less arid southern regions is very gradual. A certain amount of rain falls between July and September, but this is very irregular, and some years may be practically rainless.

The semi-desert naturally offers a more varied landscape than the desert, on account of a more severe erosion. Small trees and a dearth of grass appear to be the most prominent features of the vegetation. First, small bushes and low, gnarled trees, either solitary or in thin groves, make their appearance. They no longer belong to the mediterranean flora, but consist largely of various species of acacias and acacia-like plants, often thorny or prickly, with small, deciduous leaves; other plants are swollen into water reservoirs; the majority are resinous or waxy. Presently, the isolated bushes cluster in loose scrub; on some of the tablelands, besides entirely bare stretches, sprinklings or even thickets of acacias occur occasionally, on others, sparse but regular deciduous woodlands are formed by a relative of the balsam-trees, *commiphora* —the aderas, on the naked soil. Grass is confined to the river-beds and to a few slopes. In depressions with

a sufficiency of ground water, groves, woods, or even extensive forests of doum-palm (*hyphaene thebaica*) are the rule; but the predominant features are the acacia, of which there are many species, some of them local, others of wide distribution, and the umbrella shape of the thorny trees arranged in scattered woods. The clayey soils, heavy and retentive, generally remain tree-



FIG. 79. Semi-desert—Nigeria.

less and give rise to marshes and even lagoons. Here and there swards of pennisetum grass may be seen. Some cultivation is now possible, the dhurra millet being the commonest crop.

Such are the general features of the belt of land, about 300 miles broad on an average, which stretches from the Atlantic to the Red Sea on the margin of the desert. It

is to be compared with similar belts round the Australian desert, especially on the northern side, and with the southern margins of the Afghan and Indian deserts. Such regions are naturally passage ways: the number of wells and water-holes increases as the desert is left behind; yet cultivation remains localized in a very

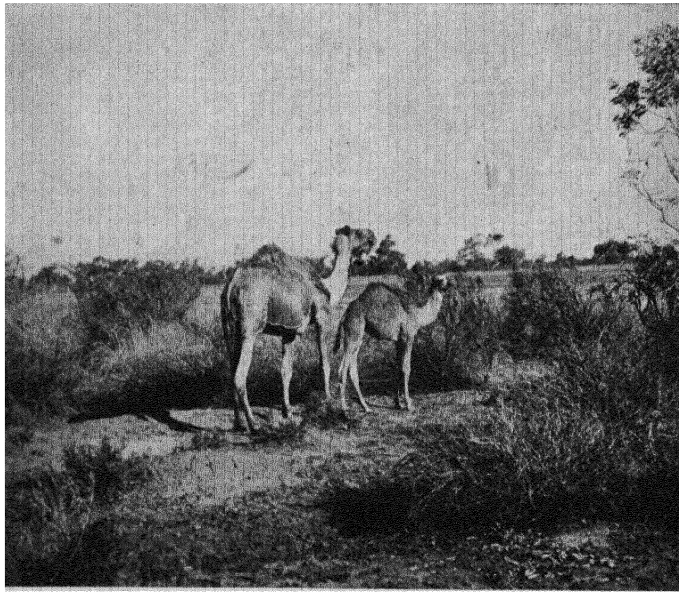


Fig. 80. Open Brush—Nigeria.

few and small areas. The tending of sheep, camels, and half-wild cattle is the main occupation of the nomad populations.

Sudanese Savana. The savana is one of the most widespread landscapes of Africa: it extends in an uninterrupted belt around the great forest region, from Senegal to the Egyptian Sudan, thence over the region

of the Great Lakes, and round across the whole of the Zambezi region back to the Atlantic. It results from the tropical climate with a moderate amount of rainfall and a long spell of drought.

Though the series of trees, shrubs, grasses, and herbs changes, the savana preserves throughout, despite differences of detail, its main characteristics of tall grass-land dotted with deciduous trees and bushes, either dispersed or in woods. So gradual are the transitions from the poorest to the richest forms of vegetation; from the desert lands, whether of Sahara, Somali, or Kalahari, to the dark selvas; that any sharp boundary between the semi-desert and the savana, or between the latter and the light tropical woodland, is out of the question. Representative forms and formations of the desert and the semi-desert continue for a time to intermingle with the specific savana vegetation, while isolated members of the high forest penetrate far into the park-land.

The Sudanese savana belt extends from Senegal to the Upper Nile amid a varied landscape, now of high table-lands, now of lower plains. Some kind of acacia, mimosa, or allied tree is always in sight, often gathering in loose woods, sometimes dotted singly, not unfrequently making, with many other small trees, regular thickets drowned in the tall grass. Large deciduous trees like the baobab, the ceiba, the tamarind, the sycamore, or a banyan-like fig-tree prefer to stand alone in the open. The guttifer shi-butter or butter-and-tallow tree is also one of the economic features. Palms of the borassus type and kernel oil-palms form groves in the south, whereas the doum-palm prevails in the north. The raphia wine-palm adorns the margins of rivers and lakes.

Senegambia is a low tract of land of a decided savana type, while retaining a number of semi-desert plant forms. South of the Gambia, the vegetation increases in variety and luxuriance as it approaches the high-forest region; yet the intervening sandstone plateaus offer but stunted forms of woods and scrub, in which acacias are predominant. Farther east, to the south of



Fig. 81. High Savana Brush—Nigeria.

the Niger, the high tablelands are mantled with tall grass interspersed with bushes, among which is the landolphia rubber-bush. Trees are comparatively rare and scattered, so that an open tree-steppe is formed: towards the south, they fail entirely. In the plateau, rivers have cut deep and narrow valleys the slopes of which are forest-clad.

This district gives way to the vast Niger-Benue plain which resumes the character of park-savana, considerable portions of the plain being under an impenetrable grassy jungle, or again under orchards of small trees overgrown with a rank crop of gigantic grass. Rivers, now broad and at a level with the land which they frequently flood, are marked from afar by fringes of tall palms or dense margin-forest. Towards Kano, the savana passes rapidly to the acacia half-desert.

Lake Chad, which occupies the centre of a vast arid depression, at the point of transition from the half-desert to the true savana-land, is girt with a broad belt of swamps, and the delta of the Shari River is covered with a dense growth of acacias. Following to the south-east, the territory of the Middle Shari is also part of the typical park-savana which displays here a variety of trees, the acacia type predominating with the butter-and-tallow tree, the tamarind and baobab. Nearer Lake Chad the clayey nature of the soil gives rise to immense swamps and lagoons, partly overgrown and surrounded with reeds, an infertile, sweltering, and often impassable land.

The Nile portion of the savana, the Bahr-al-Ghazal basin, exhibits much the same characteristics with a tendency towards the thornbush type. It is marked by an abundance of doum-palms and several forms of the Nubian flora. Amid the uniformity of the grassy plains arise sometimes rocky islands, some 600 to 900 feet high, which are clad with a very luxuriant tropical forest and defended by belts of dense acacia thickets. In the vast swamps of this district grow the papyrus, the common tall reed, and a kind of wild sugar-cane. The Sudan savana supports a comparatively large population engaged in agriculture and cattle-breeding. With the

remarkable wealth of its natural resources it bids fair to become one of the most prosperous parts of Africa: situated between the desert and the high forest, which are both avoided by man, it attracts the whole human and animal population. The conflicts arising out of differences between the nomadic and the settled, the pastoral and the agricultural, tribes have long retarded the development of the Sudan, and given a chequered history of spells of prosperity followed by periods of decay.

Futa-Jallon. A narrow strip of elevated tableland, the watershed between the Niger and Guinea, from which the West African rivers arise, is crowned with broken granitic peaks and heights, 3,500 to 4,500 feet in altitude. These broken plateaus, bounded on the north by the Sudanese bush and on the south by the high forest of Guinea, display dreary and treeless vistas of monotonous grass-lands: the carpet of meagre and short grass, about one foot high, is interspersed with *Labiatae, Scrophulariaceae, Convolvulaceae,* and *Compositae*: the medium-sized trees, gathered in sheltered situations, are of a deciduous, temperate type: in short, the landscape reminds one strongly of the European scenery and atmosphere. The treelessness of those plateaus appears to be due to a wholesale destruction of the forests rather than to any influence of climate or soil. The sunk valleys are more prosperous, and harbour patches of tropical forest on their slopes, while the bottoms are covered with gigantic grasses, 9 to 10 feet high.

Egyptian Sudan. This region, which continues southward the great Libyan desert and extends across the middle course of the Nile up to the foot of the Abyssinian plateau, skirting the latter southward to Lake Rudolph,

shows an improvement on the semi-desert margin, and marks a step towards the more prosperous savana conditions, for the rainy season may be fairly depended upon. The vegetation is uniform, and characterized throughout by a large development of thornwoods (cf. p. 213).

In the north one still meets with large stretches of desert land, especially on the plateaus, while in the broad depressions, forests of doum-palms, gummy aderas,

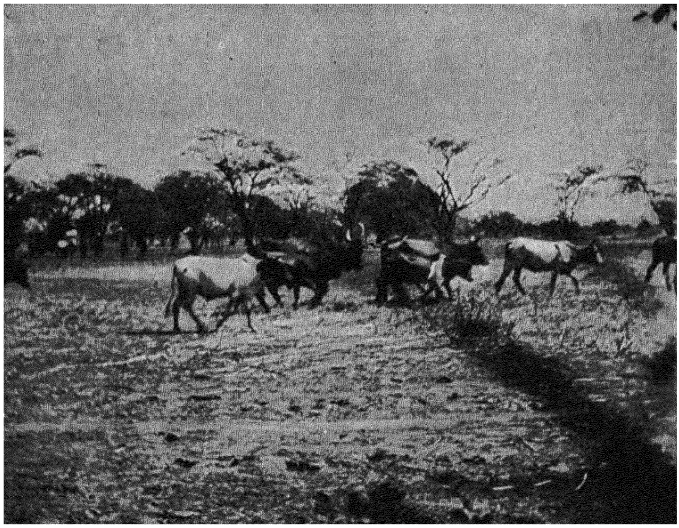


Fig. 82. In the drier Scrubland of the Egyptian Sudan.

balanites, &c., predominate with grassy tracts; but thickets of thorny Nubian and other acacias, and scrub, 3 to 5 feet high, of deciduous, tiny-leaved bushes, become a distinctive feature. As it penetrates farther south, the scrubby and thorny vegetation grows more continuous, closer, and taller. The landscape is now a mosaic of thin, shadeless woods of gnarled acacias which expand in umbrella shapes, and in many ways recall our

orchard trees in winter. There may be a bushy and woody undergrowth, but generally the stony ground is bare under and between the scattered trees. Meagre steppes of dry and wiry bunch-grass alternate with knee-high scrub, now open, now fairly close. The thornbush vegetation of this region may be compared to that of the sertão in the north-eastern part of the Brazilian highlands. Extensive tracts among the wood- and scrub-lands are covered with peculiar grass formations

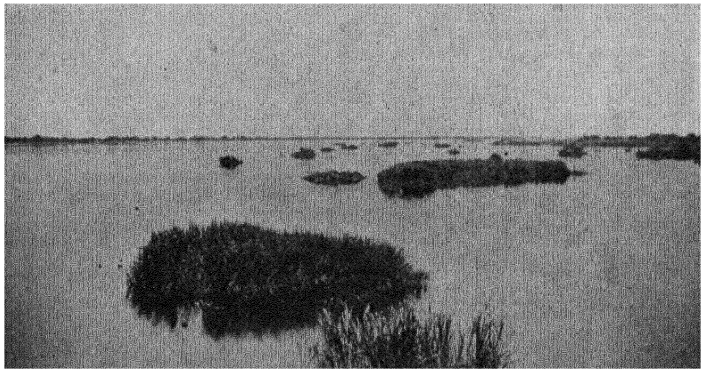


Fig. 83. Floating Blocks of Sudd.

which suggest meagre and patchy cornfields on a stony soil, and constitute a specific feature of those regions.

The lower portion of the district, in the immediate vicinity of the Nile and under its beneficial influence, shows already something of the luxuriance of grass of the savana. The river flows between banks adorned with groves of palms and other tall trees; but behind that fringe and occasional strips of savana, commence the leafless, thorny scrub and woodland. The river forms vast swamps bristling with tall reeds, papyri, sedges,

canes and rushes, and cloaked with sudd, which may so cover the marshes as to seem like a regular growth, which completely hides the waters and assumes the appearance of our meadows. A fishing population of most peculiar habits lives amid those swamps. On the savana and the other poor steppes, as well as in portions of the scrub area, a certain number of cattle can be supported, for the nature of the country compels pastoral activities. Agriculture is confined to the vicinity of the

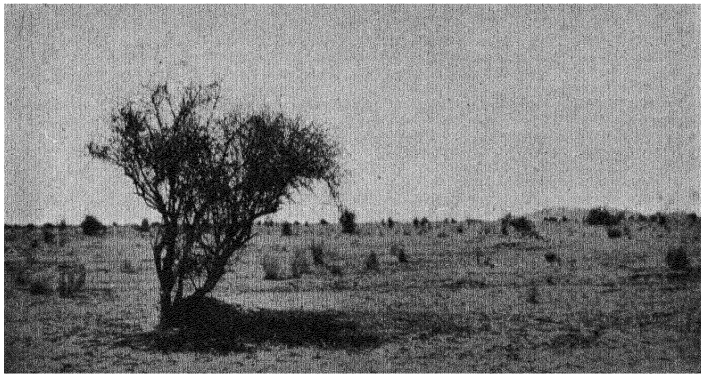


FIG. 84. The Desert near Rogel.

rivers and to the higher lands which receive a somewhat more generous rainfall. The woodlands are of no special economic value, but they supply an abundance of fuel for the steamboats which ply on the Nile; hence they are rapidly becoming exhausted.

Abyssinia is an enormous block of lofty tableland, topped by still loftier ranges and peaks, and broken by deep and narrow gorges. While it attracts the summer monsoon rains from across the equator, it is yet so severely drained and wind-swept that the effect

of the abundant rainfall is partly lost. Varying with the altitude, its climate ranges from dry and hot conditions of the Sudan and the Red Sea to the coolness of northern lands. In addition to this, an unequal distribution of rainfall and an extreme diversity of the drainage due to variations of the relief and of exposure, and the nature of the ground combine in render-



Fig. 85. Coffee Plantation—British East Africa.

ing the plant cover strikingly varied; indeed the landscape of Abyssinia may be regarded as a summary of most of the vegetations of Africa. The most characteristic and extensive formation is the meagre treeless steppe of the wind-swept plateaus, which is, however, interrupted on the arid rocky sides of the gorges by patches of thorny brush or thin sprinklings of acacias and low leafless trees. Prosperous park landscapes

strongly recalling those of Europe are not wanting in favoured positions on the upper levels. Orchard-like woodlands, dotted with candelabra euphorbias, groves of tall deciduous trees, mountains clad with forests of gigantic juniper and podocarpus, and possessing an undergrowth of mediterranean tree-heath, vary the grassy brushes and scrub. The increase of rainfall with elevation determines a corresponding arrangement of the vegetation in belts of altitude. Thus the lower slopes, like the neighbouring lowlands, support bush grass-lands; a taller hillbush follows higher up; on the plateaus and upper slopes the park landscape with its European-looking deciduous trees and pastures becomes predominant: juniper forests are best developed between 6,000 and 9,000 feet, on the slopes of the loftier mountains.

The country is mainly pastoral, but agriculture is quite possible, is indeed practised everywhere for local requirements, and with primitive methods. Abyssinia is also the home of the Arabian coffee-tree, and shelters two kinds of wild olive-trees and a great many plants of economic interest.

The mountains of Yemen in Arabia Felix offer a close analogy with Abyssinia, the ancient Ethiopia, both as regards climate and vegetation, and it is not surprising that the population of the latter was partly derived from the Arabian Sabeans, who brought with them their civilization. Ethiopia was also influenced by Egyptian invasions and became an important centre of culture.

Abyssino-Eritrean Foot-hills. The land gradually rises from the low and arid Somali plains towards the Ethiopian highlands in a series of broken terraces which form a hilly landscape. This is carried towards the east up to Cape Guardafui by an irregular line of low

mountains, and is continued by the hilly ranges which join the Eritrean coast with the northern part of Abyssinia. An increase of rainfall during the wet season, a greater diversity of soil, and the occurrence of clouds and mists in the upper reaches go to make the vegetation of this hot belt much more varied than that of Somaliland proper. A large development of the grassy thornbrush and acacia scrubs, a wealth of orchard-like woods against a background of grass-lands are the specific features of this scenery, which, on the whole, repeats that of the Brazilian sertão.

A number of strange plant-forms imparts a peculiar character to these dry grass- and scrub-lands. Among them, the candelabra euphorbias, the stiff-leaved aloes, the compact, low and rounded crowns of the dragon-trees, and, strangest of all, the barrel-shaped adenium-trees with their bodies swollen and smooth, and their crowns of short stout limbs ending in small bunches of leaves, arise solitary or in loose clumps on the slopes: gum acacias are also abundant.

In the north of this region the scorched hills of Eritrea support forests of balsam-trees, leafless, except for a few weeks in the year; shadeless, without grass or undergrowth of any kind. Such woods look like copses of dead young oak-trees, left standing on naked stony wastes. The cloud-belt favours the growth of more regular forests of tall junipers, podocarpus and tree-heaths interrupted by pastures, identical with those of the Abyssinian highlands. It was principally on the slopes of this transition belt that the Sabean herbalists found the gums, resins, and aromatic products, myrrh and frankincense among them, which were the objects of an extensive trade in ancient times.

Yemen. Across the Red Sea, the hilly margin of

Arabia repeats very much the same landscape and the same vegetation as the symmetrical mass of Ethiopia. The raised south-western edge of the great desert plateau, which in places exceeds 9,000 feet in elevation, attracts the monsoons from the Indian Ocean in the same manner as does Abyssinia. Hence, on the middle and upper slopes, there is a sufficient rainfall, which is supplemented by an abundance of clouds and mists and by plentiful dews at night. The climate is equable, warm temperate to subtropical. The streams have eaten their way far up into the tableland and dissected its jagged rim into a network of deep valleys; but on reaching the torrid coastal shelf they are swallowed up by the sands, or evaporated. Such fortunate conditions convert the highlands into an island of abundance amid the surrounding deserts.

The vegetation combines the features and profusion of the mediterranean and moist subtropical types; but it includes also many characteristic forms of the adjacent dry lands, thanks to an extreme variety of physical conditions. Hence the extraordinary wealth and diversity of the natural and cultivated resources which gained for the Yemen, in ancient times, the name of Arabia Felix. It is largely the vegetation of the more arid areas, reaching a point of supreme intensity, which furnishes the abundance of gums, resins, wax, balsams, scents and spices, just as among the foot-hills of Eritrea and Ethiopia. The collection of gums, cassia and senna, myrrh, frankincense and kât occupied the ancient Sabeans, and gave rise to one of the most famous trades of the remote past. The civilization of the Minoans, Sabeans, and Himyarites spread as from a centre to Syria, Ethiopia, and Babylonia.

Somaliland, 'the Horn of Africa,' is a region inter-



FIG. 86. Somaliland: Characteristic Stony and Thorn Country

mediate between the Sudan and Arabia. The rain-bearing monsoons on their way to the lofty mass of Abyssinia pass over this thirsty, sweltering lowland, grudging it the benefit of their moisture. Thus the plant cover is reduced to a minimum, which renders the country very similar to the arid margin of the Sahara. A meagre sprinkling of umbrella-acacias and other low trees, thorny and leafless, over the bare sandy or stony ground is quite typical of this region. Now bushes gather in open scrubs; now light acacia woods mark the tracts of some underground moisture: a dotting of stiff grass-bunches or of prickly, leathery, strap-leaved plants recalling pineapple bunches, may form the scanty undergrowth. Grass is scarce and bad; pastures mostly temporary and localized. A rich development of thorny plants, a general umbrella shape of the tiny-leaved deciduous trees of low woody and bushy growth, are, with the strange forms of the candelabra euphorbia, species of aloes and water-storing plants, specific features of the vegetation. Tamarix, calotropis, indigo, salvadora, and other denizens of the semi-desert Sudanese belt reappear in Somaliland. It is only in the margins of the often waterless river-beds that one sees impenetrable thickets of acacias and a stronger development of grass: long stretches of the coastland are completely destitute of any visible vegetation. Amid the scorching semi-deserts, two large rivers arising from the Ethiopian highlands form symmetrical replicas of the Blue Nile and the Atbāra. Their flood margins extend in places over five miles, and long sections of the valleys support dense equatorial selvas, marshes, and jungles of marvellous exuberance: a presumably true picture of primeval Egypt before the secular efforts of man brought it under control. A similar effort has

apparently been beyond the powers of the Somalis, whose thinly scattered tribes continue to tend hungry cattle, and to hunt among the rich scrub.

Light Forests and Parks of Tropical Africa. The savana does not pass abruptly to the high tropical forest: with the gradual increase of rainfall and the appearance of a double wet season, the vegetation slowly grows more luxuriant; patches of woods become at once more extensive and more frequent; while the park aspect is emphasized. Yet woodlands do not attain to the height and wealth of the equatorial selvas: a good many trees still shed their foliage or possess leathery leaves; and lianas and epiphytes, except in the river-forests, are comparatively small and scarce. In short, there is a distinct belt of transition from the savana to the selva, consisting of light kinds of tropical woods mixed with grass-lands of the savana type; but by reason of the universal practice of burning the grass yearly in the dry period, the savana has, in most cases, been extended right to the margin of the selva, and, in many instances, has indeed largely encroached upon its limits by the destruction of the belt of light woods, which are easily set on fire. Cultivation is also responsible for much of the damage to the light forests. Thus it is that, in tropical Africa, this belt has been largely transformed into a savana. Distinct traces of it may be found in the hinterland of Upper Guinea (the Ivory and Gold Coast, Togo, and Nigeria), on the watersheds of the Shari, Bahr-al-Ghazal, and Congo basins; and the great Ituri forest passes to the savana through such a margin of light deciduous tropical woods interspersed with grass-lands.

In Upper Guinea, representative growth-forms of the selva are present throughout this belt. Oil and borassus

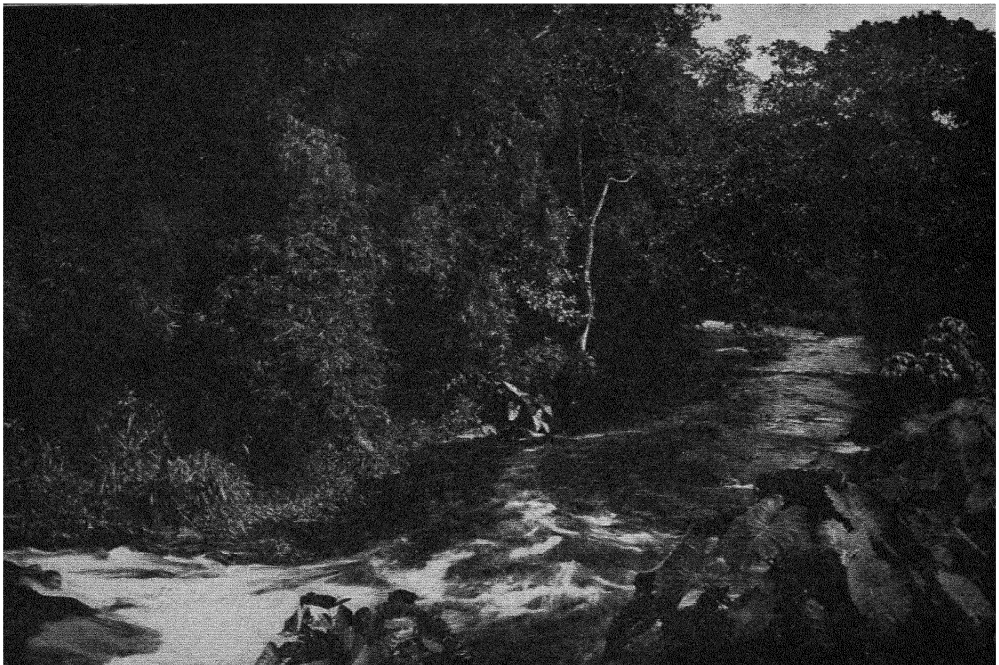


FIG. 87. Forest Vegetation, River Limbe, Nigeria.

palms form a conspicuous feature, along with ceibas, bombax, anogeissus, West African mahoganies, sterculias, fig-trees, chlorophoras, and other large trees: wild coffee-trees are abundant.

On the south of the Congo basin, the Kasai and Lualaba rivers, with their tributaries, run across a series of terraces leading up to the Zambezi divide. Here only the slopes of the valleys, deeply sunk below the general level, are clad with forests of the selva type. The tablelands are covered with a mixture of light woods and grassy glades.

This transition zone, the most fertile part of Africa, is capable of great development. It has the advantage of an easy irrigation without the drawbacks of the overwhelming forest. Its comparatively old cultivation and thick population are proofs of its natural fertility even under primitive methods of cultivation. Rice, yams, oil-palms, rubber, coffee, cotton, sugar-cane are but a few of its most important products.

West African Coast: Guinea. From the southern part of French Guinea to the Gold Coast, the tropical rain-forest extends from the shore to the upper valleys of the plateaus at the back, and penetrates along these gorges far into the savana region. The reason of this is the heavy rainfall, exceeding 80 inches and fairly continuous throughout the year, coupled with the equable heat.

The low coast-line is sandy and marked by a screen of tall coco-nuts and oil-palms. Behind this extend freshwater or brackish lagoons, girt with reeds, tall grassy jungles, and thin low shore woods. Villages are dotted all along the beach, and the natives have cleared narrow strips of ground between the sea and the dark forest which rises at the back. Frequently this sandy

shore is interrupted by tidal swamps, which mark the mouths of the rivers and inlets, and bear on their slimy surface mangrove forests. Where the hills reach the coast-line the rain-forest crowds down almost to the shore. The Guinea selva is said to be the densest and most luxuriant forest of Africa, and is now becoming famous for its wealth in rubber plants. In respect of its situation, physical conditions, and density, it is to be compared to the Brazilian coast forest on the other side of the Atlantic. This remark applies to the forests of Lower Guinea and the Loango coast, which extend almost continuously from Lagos to the vicinity of the lower Congo, and beyond that river, on the seaward slopes of the great southern plateau, to Benguella. Mangrove swamps are particularly abundant along the Gulf of Guinea, covering the low and broad tidal tracts at the delta of the Niger, of the Old Calabar, and the mouths of the Cameroon.

The enormous mass of the Cameroon mountain displays well-marked belts of vegetation: a lower belt of heavy equatorial forests, followed by a zone of dense mountain forests, reaches up to 6,000 feet; thence upwards the forest gradually dwindles to the size of a high bush and becomes increasingly mixed with grass-lands dotted with low shrubs. At 8,000 feet the shrubs disappear fast and open grass slopes lead to upper moorlands, above which the ash-cone towers. Compared with mountains in other parts of the inter-tropical world (Mexico, the Andes, and even with the Himalayas), the Cameroon thus shows an unexpectedly low tree-limit.

The Gaboon forest appears to continue east of the Oguwe and to join the great forests of the Sanga and Ubanghi.

West African Plateaus. In West Africa there occur

a few masses of higher plateaus, the vegetation of which differs in many respects from that of the surrounding lands. The Futa-Jallon has already been briefly mentioned. Other highlands occur in Togo, in a general north and south direction. North and east of the Cameroon the extensive tablelands of Adamawa and Ngaundere separate the interior basin of the Chad from the basin of the Gulf of Guinea, and possibly continue between the Gaboon and the Congo basins. Here rivers flow at the bottom of narrow gorges which harbour dense and luxuriant forests of the selva type. The hills and plateaus, on the other hand, display a dry kind of vegetation, contrasting with the exuberance of the Cameroon and Gaboon. There seems to be a recurrence of the flora of drier lands, with the acacias and other plants of the Sudan: mixed brush-woods of middle-sized deciduous trees alternate with grass stretches in a park landscape: forests of *Combretaceae* display in January a fresh pale and shimmering verdure; palms are rare, epiphytes and climbers both scanty and small. The drier character of these plateaus is possibly due to the more complete drainage, and to the winds. Similarly, the little known hill- and plateau-land which forms the watersheds between the Shari, Ubanghi, and Bahr-al-Ghazal basins, appears to have a vegetation different from that of the valleys, composed of light woods and park-lands, in which the baobab and the borassus palm fail. The trees are small or of moderate size, and include amongst others the butter- and tallow-tree, numerous members of the acacia and mimosa tribes, and many other shrub forms with small leaves.

The plateaus to the north and east of the Cameroon are, to a large extent, under prosperous native cultivation.

The Congo Basin ' is a circular plain-like basin, some

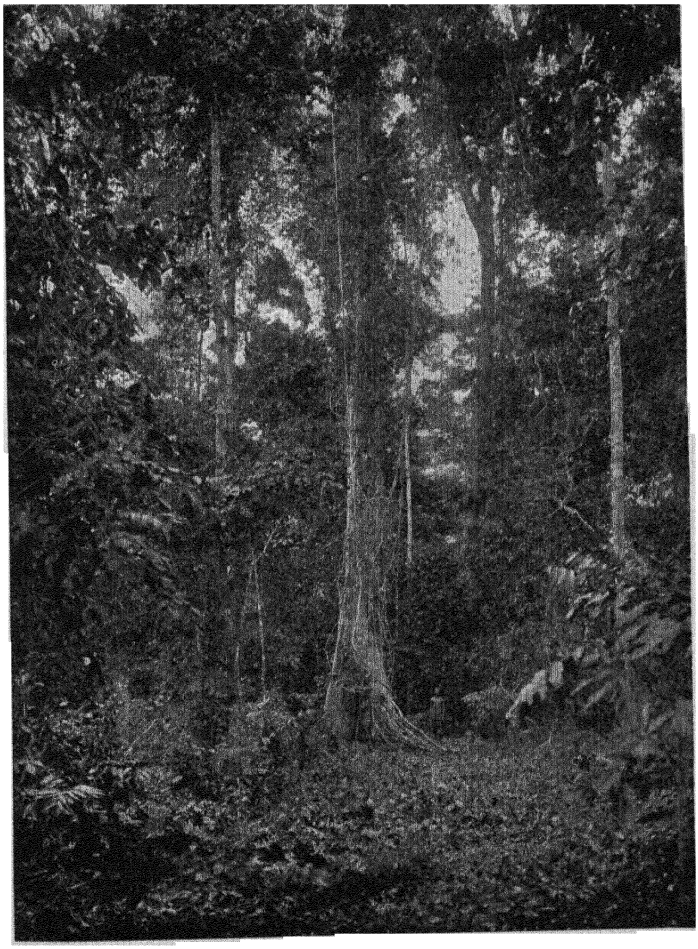


FIG. 88. Tropical Forest in the Congo State.

1,500 feet above sea-level, surrounded on all sides by the edges of higher plateaus'. It was long described as one colossal and unbroken stretch of equatorial rain-forest, yet it appears to receive a rainfall that hardly exceeds 80 inches yearly. Perhaps the impression of boundless selva which is recorded in the accounts of more than one traveller is due, as on the Amazon, to the fact that explorers seldom ventured far from the rivers, thus having no opportunity to see the back-country. From the edge of the plateau, for hundreds of miles up stream, the main waterways are accompanied by wide belts of true selva. This is true for the lower Sanga and the Ubanghi up to its eastward bend, for the Congo up to Stanley Falls, and for the lower Kasai. As in the Amazon these broad strips on both sides of the main streams are liable to permanent or temporary floods; and on the middle and upper sections of the rivers, the selvas confine themselves to narrow fringes. The Congo high forests are of the equatorial rain-selva type, like the Amazon caaguapu in all its essential vegetative features, much as the floras may differ. Oil and borassus palms, which were present in the savana, continue to be conspicuous in this region: rubber-trees and lianas are found in abundance and heavily exploited. Among other interesting trees may be noted the dragon-tree, which is well represented in drier regions, the fig-tree, rotang palms, ceibas, &c.

The nature of the vegetation covering the tablelands between the rivers has not as yet been satisfactorily studied. In the Welle district, beyond the margin forest, opens a park landscape of light woods and savanas; the Itiri forest, partly of the rain-forest type, turns to a lighter kind towards the east; and in its middle course the Kasai runs also through a variegated scenery of light

woods and grass-lands. Such characteristic denizens of the savana as the ceiba, dragon-tree, borassus palm, &c., by their recurrence among the inter-river landscapes, suggest a similarity of conditions between the two physical environments. In the lower districts of the Congo, the selva is limited to the shores and the islands: savanas become the chief plant formation, corresponding with a lower atmospheric humidity.

Human settlements are scattered along the rivers, where, by fishing, hunting, and a minimum of agriculture, as well as by the collection of rubber, scanty populations, once more prosperous and numerous, eke out the meagre living that satisfies them.

Angola. The northern edge of the high austral African plateau curves round the Congo basin. Its north-western extremity passes quite close to the lower Congo, forming the region known as Angola, which possesses a low and narrow coastal shelf. This coastal strip is but the northern spur of the south-western desert, and its rainfall does not exceed eight inches yearly. Consequently its vegetation repeats that of Somaliland or Gazaland: meagre and patchy swards of stiff grass, with a sprinkling of thorn-bush and stunted trees, where the forms of the candelabra euphorbia and the baobab, the aloe and the sanseviera are conspicuous.

On the foot-hills at the back, the thorn-bush thins out and soon mingles with jungles of large-leaf evergreens. Climbing up the edge of the plateau, at about 1,000 feet, one crosses the southern outlier of the West African coast forest, comprising high trees and lianas, which has been already mentioned. The forest belt rapidly decreases in size and profusion, as one approaches the brink of the tableland, and after passing through a fringe of hill-bush one steps into the boundless savanas

which cover the whole breadth of the South African continent. The coastal hill forest rapidly dwindles towards Benguella, and is replaced by the jungle and the thorn-bush. Rubber and the Guinea palm-oil are the best known resources of the rain-forest belt, but cultivation, which is here fairly extensive, comprehends many tropical products, amongst which coffee, cotton, and sugar-cane are the most important.

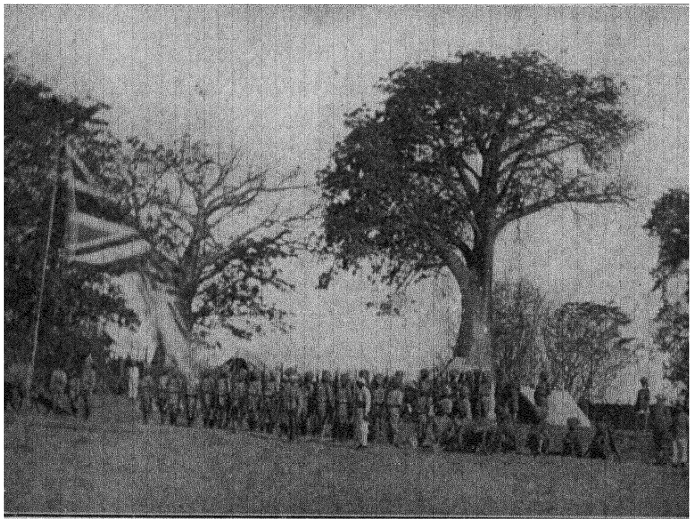


FIG. 89. The King of the African Savana. Baobab tree.

East African Mountain Region. Under this name may be included the variegated landscape of terraces, escarpments, hills, and mountains which border, and lead on to, the South and East African plateau from the eastern coast. It comprises also the rolling and hilly land north of the Victoria Nyanza, the broken country which skirts the eastern rift, and the hills west and east

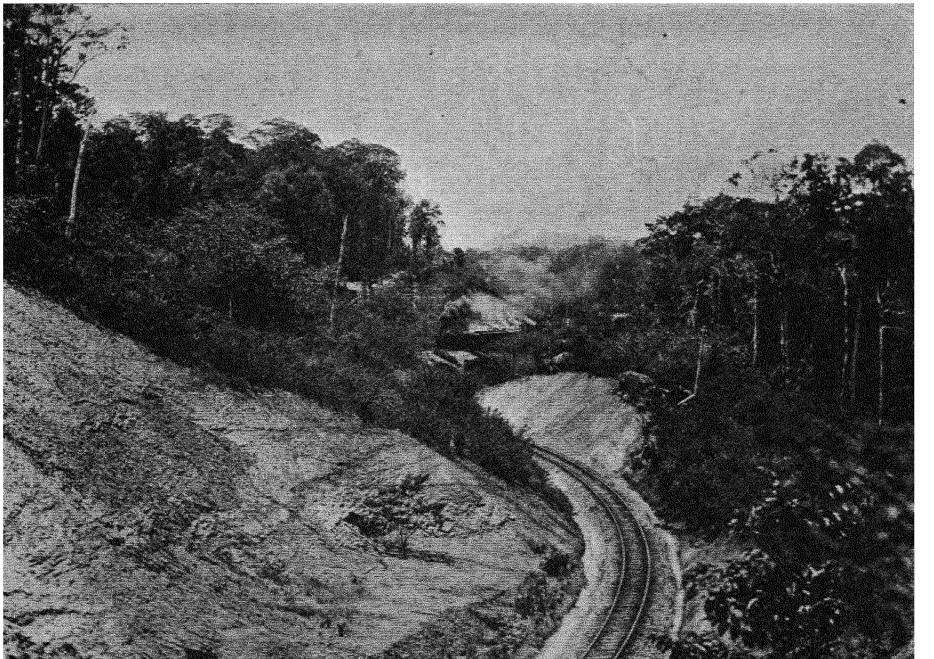


FIG. 90. Railway cutting in a Tropical Forest—S.E. Africa.

of the Nyassa, south to the lower Zambezi. The region thus defined embraces a manifold scenery: it differs alike from the Somali half-desert, from the Bahr-al-Ghazal savana, from the Congo forest, from the Zambezi savana, and from the drier lowlands of Mozambique: yet despite its diverse aspects, from the forest-clad hills of the Shire to those of the Upper Nile province, it has a certain unity.

Several factors, such as the varying but generally high altitudes, the equatorial and tropical situation, the unequal influence of the south-east trade-winds, the diversity of the drainage, and the nature of the soil, combine to make this region one of the most varied of the continent. The background and general theme of the picture is always some kind of savana or thorn woodland, corresponding to a—for the tropics—moderate rainfall. From this rise light tropical woods and even high forests, but by reason of the great elevation of the plateau on the west and of the drought nearer the coast, the savanas are generally poor, and the deciduous thorn-brush or wood of the caatinga form is the typical vegetation except in the south, where a dotting of acacias with the umbrella shape prevails. Thus this part of Africa offers a great similarity to the northern Brazilian highlands, and for similar physical reasons.

As a rule, the eastern and southern slopes possess a richer vegetation than those of the west and north, most of the rainfall coming from the south-eastern trades and monsoons. Light kinds of tropical forests do not fail in the hill-land. The best known is the Mau forest, large portions of which are only of moderate height, 60–70 feet, trees with thin light crowns and thick gnarled trunks, and few lianas, few climbers, but a dense undergrowth of shrubs and grass: other parts approach

the exuberant subtropical rain-forest. Hill rain-forests occur on most of the mountains, the lower portions often assuming the true selva type. Inland valleys are, in many instances, extremely dry. In the Athi and Kidwani valleys, extensive tracts are thinly studded with umbrella-shaped acacias over a meagre carpet of low grass. On the other hand, the regular park savana is exemplified beautifully in the Masai and Karamoyo plains.

The belts of altitude can be traced distinctly up the four great mountain masses of the Ruwenzori, Elgon, Kenya, and Kilima-njaro. On the first-named the different zones are the following, with reference to the Uganda side:

	ft.
Snow	
Tree senecios and shrub lobelias, a loose bush up to . .	14,200
Tree-heaths up to . . .	12,000
Bambu forests up to . . .	10,000
Tall forests up to . . .	8,700
Savanna and bush up to . .	6,500

Two conifers, the tall juniper and the podocarpus, may be found in Masailand.

Towards the south, among the hills, the vegetation passes to a more uniform type of deciduous monsoon forest, all varieties of which are to be seen on both sides of the Nyassa and in the Shire district, south to the lower Zambezi: north-eastern Rhodesia especially displays several large belts of them. They reappear south of the Zambezi on the hilly terraces of Umtali and Barue, south to the Sabi River.

Populations of hunters, shepherds, and agriculturists are naturally intermixed amid such varied surroundings, but, as usual, the hunting and pastoral tribes, being

more warlike, have established an ascendancy over the tillers of the soil. These countries are capable of a prosperous development under the influence of the white man: the Uganda plateau, especially, offers a vast scope on account of its healthy climate. Several animal foes such as the tsetse fly and the tick, however, will have to be stamped out before a regular settlement is possible.

The Zambezi basin and Unyamwezi. As far as we know, the vast plateau territory which sweeps round from Angola to the Great Lakes over the Congo-Zambezi divide and most of the Zambezi basin, and beyond Tanganyika to Victoria Nyanza, offers throughout a fairly uniform type of savana repeating, though at a much higher elevation, the physical conditions of the Sudan. Under the general influence of a characteristic savana climate, the nature of the ground and of the relief seems to be the determining factor in the distribution of the vegetation. A light tropical forest of a leaf-shedding type, which in many instances resembles a thin oak forest, is the tallest form of it. Besides this, many varieties of savana woods occur, now in clumps and groves, now even in extensive patches: among them may be enumerated: thin copses of deciduous trees with straight, slender trunks and flat, spare crowns supported by gaunt, twisted limbs; no undergrowth but grass up to three feet high; open clusters of trees of a stouter and more bushy growth with clear, round heads and fine foliage; jungles and orchards of loose-limbed acacias overgrown with tall grass; dottings of umbrella-shaped thorn-bushes in the savana with the solitary baobab conspicuous in the distance. On drier and more broken, basaltic and limestone rocks the grass and woods give way to stunted forms of grey thorn scrub relieved by shrubby evergreens and woody perennials. Candelabra



FIG. 91. **Settlers in Bush Country. Zambezi.**

euphorbias, aloes, and other water-storing or succulent plants, are lightly scattered among the rocky scrub.

Towards the great lakes Tanganyika and Nyassa the surface heaves up into a regular hill-land; the vegetation becomes more exuberant and is diversified by light forests, and the region passes gradually to the hill forests of East Africa.

Over the vast savana tableland, centres of inland drainage, or tracts of doubtful gradient, have developed large shallow swamps partly covered by tall reeds, sometimes girt with light jungles. On one of those swamps, peculiar tribes, living entirely on the products of the water, lead a primitive existence on floating reed-rafts, screened from the whole world which they ignore. Hunting in the once thickly stocked savana, cattle-grazing, and agriculture are the simple occupations of the inhabitants of this region.

Gazaland and Mozambique. South-east of the hill region of east Africa the coastal plains and plateaus expand greatly before reaching the edge of the high austral African tablelands. They are too low to condense the moisture of the south-east trade-winds, which therefore sweep past them without materially benefiting them. Broadly speaking, this is a repetition of the conditions obtaining in Somaliland in a lesser degree. The vegetation is correspondingly poor and, on the whole, similar to that of the latter region, or of the lowland of Mossamedes, that is, an open bush of thorn-wood with but scant grass of a wiry description. The arid landscape is broken by the deltas of the most important rivers, especially along the lower courses of the Zambezi and Limpopo, where the moist ground supports luxuriant tropical evergreen forests, and swamps create around them heavy jungles.

Boschveld. South of the Zambezi, with increasing distance from the equator and an undiminished elevation, the tropical savana very gradually turns to a subtropical type of park landscape which, under the name of 'boschveld', extends into the northern Transvaal. With a rainfall of about 20 inches, concentrated in summer, this is essentially a grass-land, the low growth of which no longer compares with the tall tufts of the tropical savana grasses, but consists largely of short andropogon and aristida forms. Numerous small herbaceous bushes with small leathery leaves, especially composites, are freely interspersed among bulbous and tuberous plants; there is no longer that variety of trees which prevailed within the tropics. Trees are mostly bushy, and acacias form the bulk of them, with low and flattened crowns as a characteristic feature. 'They are scattered singly or in groups over the surface and their dark foliage contrasts strikingly with the lighter green or faded straw-yellow of the sward.' Especially noticeable here are the thorny *acacia horrida*, and the mopani-tree which alone, or almost alone, successfully resists the yearly grass-fires: the majority of trees shed their foliage in winter. On granite hills, like the Matoppos, the grass plays but a secondary part, and the woody perennials and bushy tree-forms become more prominent. It is a barer landscape, but more varied in forms of vegetation and species of plants.

The boschveld may be compared with the prairies of Texas, in which the mesquite would be replaced by the acacia and the mopani-tree. It is closely allied in appearance and mode of life with the park scenery of East Africa, and is primarily a grazing ground. Agriculture can only assume the second rank as an

occupation as it requires a combination of soil and water which is realized in but limited areas.

Hoogeveld. The South African plateau continues in an increasing gradient towards its south-eastern edge, which is called the Drakenberg. The combined influence of winds, drought, and soil has prevented tree-growth, and, following upon the boschveld, the hoogeveld extends on the south at an elevation of from 4,000 to 5,500 feet, a vast, level, treeless expanse; a steppe with a short and irregular sward, only to be compared to the other vast steppe-regions, the American prairies and the Asiatic steppes. Table-like eminences called kopjes rise here and there above the general level of the plains, a thin sprinkling of stunted bushes on their often steep and rocky scarps. Otherwise, not a pebble, not a shrub, breaks the monotony of the endless plateaus: trees are restricted to the immediate vicinity of the water-courses and of human settlements. The dry and cool climate of the hoogeveld renders it the healthiest part of Africa. The pastures originally supported quantities of wild cattle and big game, and the huntsman and the herdsman found there abundant occupation. Large numbers of cattle, however, could not be grazed permanently on the same spot; hence arose the necessity of shifting the pastures and hunting-fields and, partly, of the nomadic life led by the white invaders, in their turn.

Drakenberg. The pastures are carried right over the raised edge of the plateau which has been so carved into hills as to deserve the name of mountain-range. A rain-supply falls upon the Drakenbergs sufficient to justify the presence of forests, were not these mountains exposed to the full strength of precisely those south-easterly blasts which bring the rain. Thus the beneficial effect of the latter is counteracted, as far as tree-growth

is concerned, by an exaggerated evaporation, and woods of a marked deciduous and temperate type are confined to the bottom of the valleys. The landscape of the Drakenberg is thus one of grassy dales and gorges varied with shrubs and perennial herbs, typical pastoral scenery.

Kalahari. The strength and moisture of the south-eastern trade winds are exhausted before the central and western portions of South Africa are reached: the westerly winter storms, on the other hand, exercise but little influence over these portions. Thus the vast regions lying to the south of the subtropical boschveld depend for their life-stirring moisture mostly on local winds and storms, or again on north winds and sea-breezes which cool in winter on reaching the high plateau. Hence the extension of broad, arid lands, the dry character of which goes on increasing from east to west, so as to reach a truly desert condition on the Atlantic coast. The average rainfall oscillates about four inches, but is very irregular from year to year. The Kalahari is the largest of those regions and occupies the centre of the high tableland. West of the boschveld of Rhodesia and Transvaal the trees are gradually more scattered and lower, and the grass is thinner and shorter. Now table-like tops and vast plains may be seen bare and rocky or with a ragged mat of poa grass. Thorn-bushes, especially the acacia with its tusk-shaped thorns, form loose thickets in the dry beds of the streams, amid wiry tufts of dry andropogon and aristida grasses. In similar situations the tree euphorbia and the aloe, with a small number of low, heath-like, woody trees and short sage-bushes are thinly spread over the whole area of the Kalahari; the only portions which are really plantless are the valleys or level depressions and dry salt pans, for scattered succulents speckle the stony

scarps. The South African waste land is almost symmetrical with, and analogous to, the Algerian high plateaus in point of forms of growth, though perhaps not so destitute of trees.

Damara Desert. A rainless strip along the coast from the Cunene to the Orange River, but broadening somewhat in the middle towards the Namib region, reaches purely desert conditions. The sandy strand extending inland by means of dunes is plantless, over miles and miles. In places may be seen that strangest of plant-forms, the *welwitschia*, a solitary stumpy pigmy-tree, buried in the sand, only showing its woody head, whence emerges a crown of long tattered ribbons of leaves coiling over the ground. Again, on sandy wastes may occur here and there an open brush of bushy, leafless, fleshy euphorbias. Stony troughs harbour a sprinkling of thorn-bush and trees: giraffe acacias, thorny acacias, tree euphorbias, &c. Plateaus, chiefly characterized by a vegetation of bulbs and tubers, are found farther inland. In comparatively wet years the ground is covered with the crawling melon plant, *acanthosicyos horrida*, which supplies a most welcome food. In the interior, a few grassy depressions afford some temporary pastures.

Karroo Region. The Kalahari is carried across the Orange River to a scarcely less monotonous plain, treeless and dotted with stunted bushes, though in the moister depressions grassy patches are found interspersed with shrubs and the ever-present thorny acacia: these alternate with heath-like wastes covered with short brushes of dwarf shrubs of a dull-green hue. Beyond the edge of the plateau, which is thrown into a mountain-like range, one descends to a lower terrace called the Karroo.

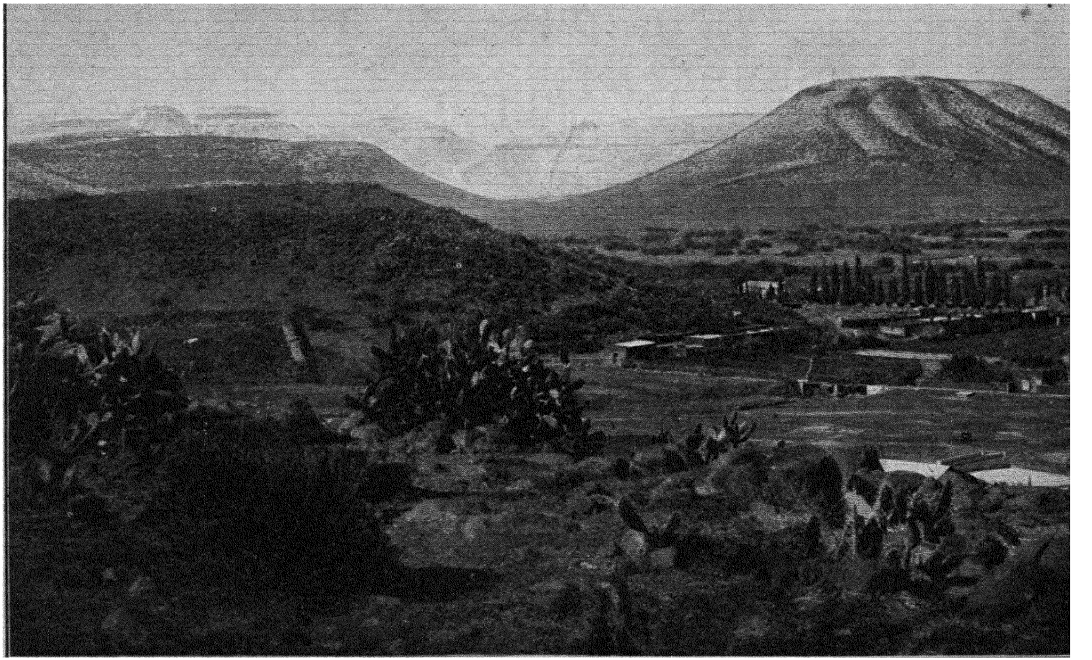


FIG. 92. The Karroo.

The Karroos are also treeless waste lands, mostly stony and semi-desert, likewise the homes of dwarf rounded shrubs, with tiny, heath-like leaves: in some years the rainfall may reach the minimum of one inch. A very large number of tubers and bulbs is characteristic of the Karroos, which are thus divided into deserts of bulbs and succulents and deserts of dwarf shrubs, and end where continuous grass begins. In the dry river-beds is loose scrub of the horrid tusk-thorn acacia, the giraffe acacia, the olive-like capparis, a sumac, the karreeboom, and a herb with fleshy leaves, in addition to numerous pelargoniums and oxalids. Few oases occur among those deserts and semi-deserts, human settlements are, of necessity, confined to river-banks: animal life cannot be plentiful on such a meagre fare, and agriculture and grazing are out of the question. There remains only the ostrich, the specific bird of the desert which is bred for its feathers on regular ostrich farms. Natives who have been driven there by more powerful tribes and by white men live permanently on the verge of starvation and at the lowest stage of destitution, and are fast disappearing.

Southern Belt of South Africa. The Cape Region receives the benefit of the winter rains due to the westerly winds, and by reason of its position enjoys a climate very similar to that of the Mediterranean. On that account it exhibits a vegetation which stands in close relation to that of extreme North-West Africa: a wealth of evergreen, small- and hard-leaf shrubs and small trees of spare vegetative habit but profuse flowering. Forest growths similar to those of the mediterranean oaks and pines have disappeared; the woody formations are reduced to the condition of maquis, with a small, leathery, and simple foliage, among

which proteas and leucadendron are the best known types. A large number of extremely varied shrubs and heath-like plants, usually well represented in our conservatories under the name of 'Cape heaths', is characteristic of this region. In addition, a diverse flora of bushy perennials, of bulbs and succulent plants, which appears like an

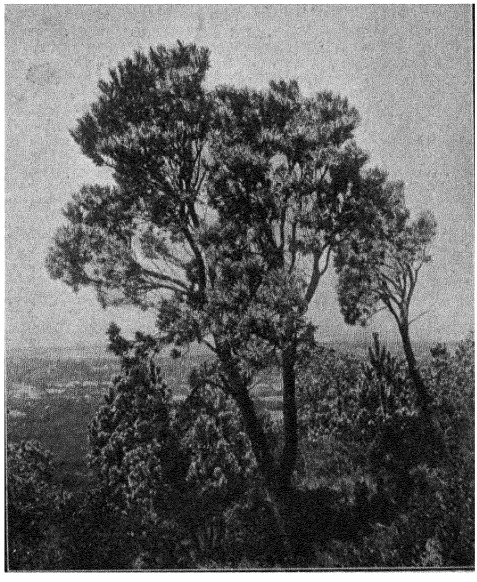


FIG. 93. Silver trees.

enriched replica of the Mediterranean flora, has furnished us with a large collection of ornamental plants.

This south-western margin of the South African table-lands has been so dissected by deep valleys as to fall into a hilly scenery in which altitudinal belts are well marked. A broken strip of coast and lowlands, which receives the minimum of moisture, includes the strand

and dune formations, among which are remarkable bush-lands and shrubby heaths, recalling the Brazilian restingas. *Acacia cyclops*, introduced from Australia, has spread abundantly, and has materially altered the original aspect of the landscape. Characteristic also of this coast strip are the numerous representatives of the sedge-like order of *Restiaceae*, which, together with myrtaceous shrubs, form well-defined vegetation units on shifting sands resting on clay or hard pan. The foot-hills support the typical evergreen hard-leaf scrub: along with these maquis occur hill heaths akin to the garigues, both of which probably replace the destroyed woodlands. With increased rainfall, cloud, and mists, the upper mountain belt displays, in isolated areas, mountain swamps, rock heaths and mountain brushes, the aspect of the whole suggesting the bush of the coast strip rather than the maquis. A pseudo-alpine low vegetation crowns the wind-swept ridges.

There seems to be no doubt that the Cape region once possessed luxuriant forests of the Mediterranean type, and that the same process of destruction which gave origin to the European maquis largely also transformed these forests into mere brushes. The Mediterranean cypress, the cedars of the Atlas and Lebanon, find an equivalent in the *widdringtonia*, so much like the Monterey cypress of California, which had formerly a large area of distribution. The last few survivors of those stately and useful trees are now left at about 2,700 feet, in inaccessible positions on the northern slopes of a remote mountain range (Cedar Mountains).

Knysha Forest. Almost the only natural timbered tract left in South Africa occurs in a narrow and hilly strip along the coast, from Mossel Bay to Algoa Bay. The forests are regular, tall and dense formations

of various evergreen trees with a glossy foliage, due to a rainfall amounting to 36 inches yearly and spread over the whole year; epiphytes and climbers abound in portions of them, as in the warm temperate rain-forests. This timber belt is intermediate between the mediterranean and the subtropical rain-forests. There is a remarkable parallel between the central valley of Chile with its mediterranean vegetation and the temperate rain-forest on the south of it, and the sequence of the Cape and extreme South African forest region. The Knysna forest was more extensive in former days; its area has been greatly reduced by the axe and the fire, and, as usual, the early mistakes now cost much money and energy to repair. Reafforestation is more difficult and more costly than would have been a wise husbanding of the natural resources.

Kaffraria. Crossing the Drakenberg, one descends into Kaffraria. This region consists of a succession of broad terraces open to the south-east winds and possesses a fairly abundant rainfall, the effect of which is here again partly counteracted by the winds. The northern and upper parts are covered with a park vegetation of a warm temperate type. Woods are not uncommon among the northern hills; but they assume the form of dense jungles of slender, twisted, and distorted trees of small stature, giving the impression of overgrown elfin woods. Upon the mountains are found two conifers, *podocarpus* and *widdringtonia*. For the most part, however, the middle and upper terraces support park or bush grass-lands, where acacias, aloes, and proteas predominate, and form excellent pasture grounds, not unlike those of Texas. Winters are dry and cool, and last from May to July. Many bulbous plants, varied shrubs, and perennials are found interspersed among the

grass or in colonies around the trees: the umbrella shape is also a feature of the acacias. Thickets of grey, bushy euphorbias studded with tall aloes are not rare, while the stony hills are strewn with succulents and the ever-present aloe form.

On the lower terraces, at about 1,500 feet, the climate changes to a moderately dry and hot subtropical type, favourable to the development of subtropical agriculture: sugar-cane, tobacco, maize, bananas, and other fruits may be grown with excellent results. The natural vegetation consists mostly of shrubs, thickets, and woods of small trees, among which are palms and the ornamental, banana-like strelitzia, the tree euphorbias and aloes, which latter are found alike among the park-steppes and the subtropical brush-woods. A frequent type of woodland is that of the caatinga jungles; those of a more profuse character occur in the well-watered valleys of the south.

The character of savana is strongly marked on the terrace, about 1,500 feet above sea-level, which extends between the Drakenberg and the Lebombo range in the north of Natal. This hilly district, a transition between the bush-steppe and the regular tropical savana, is sometimes known as the 'nether-veld'; without possessing the luxuriance of the savana, it has taller trees and grass than the boschveld.

Three zones of occupation may thus be distinguished in Natal: (1) the subtropical coast belt of cane, cotton, and fruits, up to 1,500 feet; (2) the temperate agricultural belt with corn and maize; and (3) the upper or exclusively pastoral belt.

Madagascar. The core of Madagascar is an elongated high plateau occupying the centre of the island, and continuing across the sea the tableland of Rhodesia. To-

wards the west the sea is reached by a series of step-like terraces, while towards the east the plateau sinks precipitously to a narrow fringe of marshy coast.

Situated within the south-eastern Trades belt, Madagascar is ever moist on the eastern scarp of the tableland,

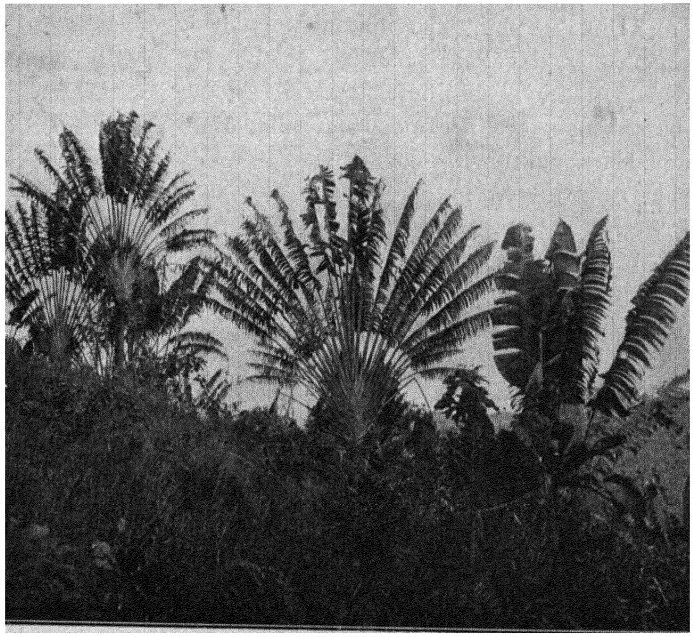


FIG. 94. Traveller's trees.

which consequently is clad with an overwhelming tropical rain-forest, descending to a margin of mangrove-swamps. The top of the tableland is naturally the continuation of the Rhodesian boschveld. The western terraces, on the whole, reproduce the condition of the hinterland of Beira, and display a similar kind of light tropical wood-

land interrupted by savanas and thornwoods. In the moister depressions, however, the vegetation may attain the profusion of the true selva. The extra-tropical southern point of the island is very much drier, and offers a vegetation not unlike that of the Karroo. Long detached from the main mass of the African tableland, the block of Madagascar, while retaining much of the plant and animal population of the continent, has developed many special types of its own, which give it a specific character. Among the curious plants may be mentioned an obelisk-like *pandanus* and, better known, the banana-like traveller's tree, the beautiful *ravenala:* several rubber-trees are also to be found here.

All agricultural industries of the Tropics find a promising field amid the varied conditions of this island. The native populations, on the whole, were more advanced than the Africans. For a time, attempts at colonization were unsuccessful, because the approach was made from the unhealthy eastern shore, but recently, decided progress has been made by settlers on the western and northern sides.

CHAPTER VI

EUROPE

General. In the general land-mass of the northern hemisphere, Europe appears like a peninsula grafted on to the western side of Asia and advancing into the middle of temperate seas. Its geographical situation, its subdued relief and the penetrations of inland seas almost to its eastern limits ensure for the small continent a great

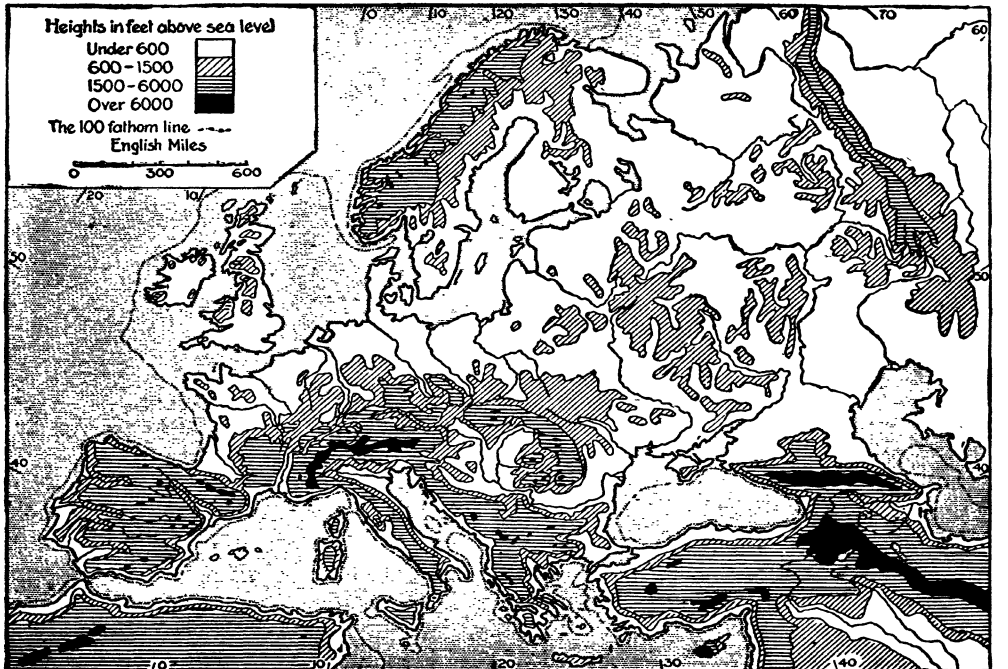


FIG. 95. Physical Features of Europe

equability and a great uniformity of climate which are its dominant features. The climate, on the whole, may be described as cool temperate, with a moderate sunshine, a moderate rainfall, moderate winds, a moderate atmospheric moisture, yet with a marked seasonal rhythm. Such conditions are the result of the westerly winds which sweep across the Atlantic and penetrate far into

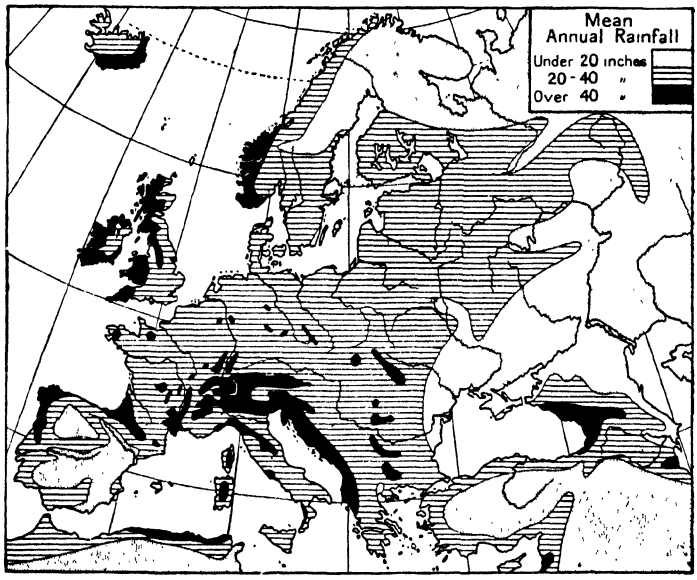


Fig. 96. Mean Annual Rainfall of Europe.

the Arctic circle. These breezes are not checked, as in Pacific North America, by transverse barriers of mountains, and therefore are able to extend their influence to a considerable distance inland. Congruous with the climatic conditions, the vegetation exhibits the same features of equability and uniformity, finding its expression in a fairly continuous cover of forests of a cool

temperate, deciduous, broad-leaf type. Of this character, the oak and beech are the foremost representatives.

In opposition to Asia, in every respect a land of sharply contrasted extremes, Europe shows gentle and gradual variations of, or departures from, a uniform temperate average, best exemplified in the British Isles as being nearer to the moderating influences, i.e. the westerly breezes. Hence the greater difficulty of characterizing what appear as delicate shades or 'nuances' of the vegetable carpet, and of indicating their geographical boundaries.

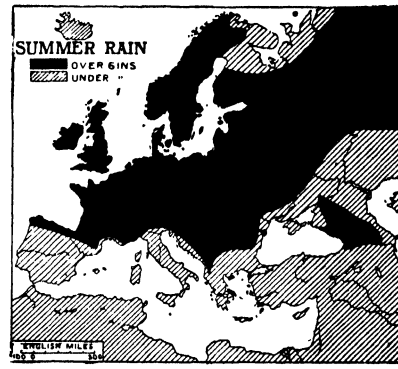
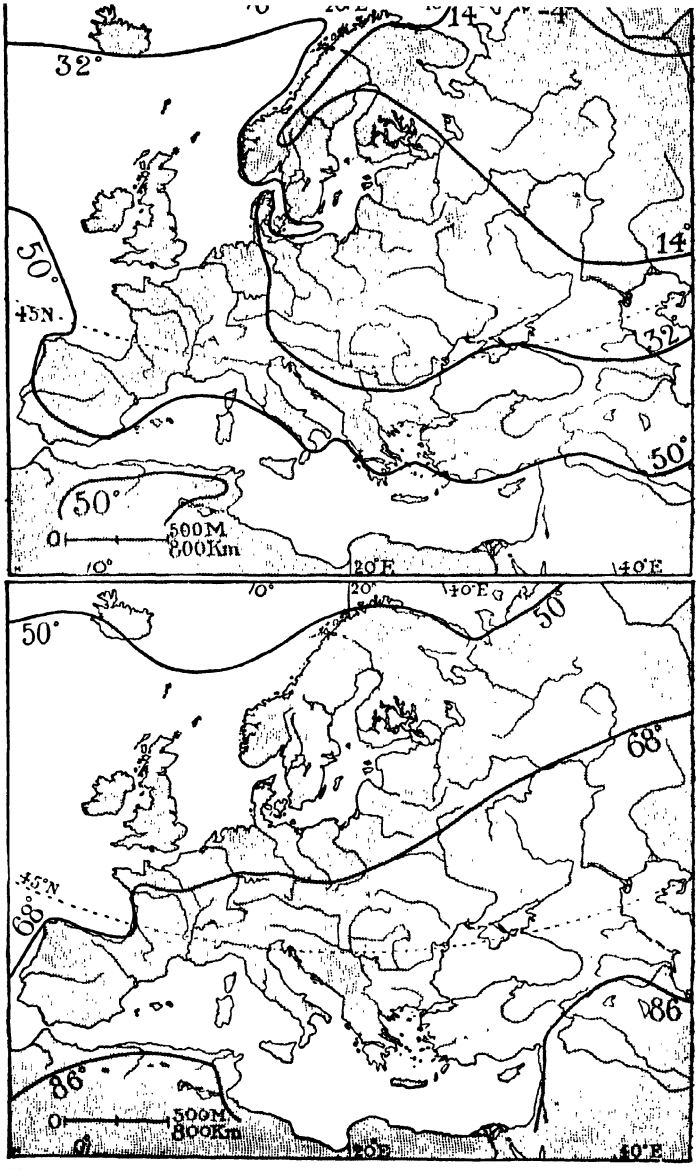


FIG. 97. Regions of Europe receiving more or less than 6 inches of rainfall during the summer three months.



FIG. 98. Regions of Europe receiving more or less than 6 inches of rainfall during the winter three months.

As may be expected, starting from the Atlantic shores and penetrating farther and farther into the mass of land, Europe may be analysed into a succession of strips or belts of decreasing equability and uniformity. The seasonal and daily contrasts tend to be emphasized more



FIGS. 99, 100. Mean Temperature of Europe in January and July, reduced to sea-level.

and more; periods of rainfall and drought are more sharply defined, and ranges of temperature, both in seasonal averages and in absolute extremes, widen increasingly. While the Scilly Isles, with their balmy atmosphere, and mild winter and summer, express the complete moderation of climate in their wealth of broad-leaf, luxuriant evergreens, central Russia with a sharp

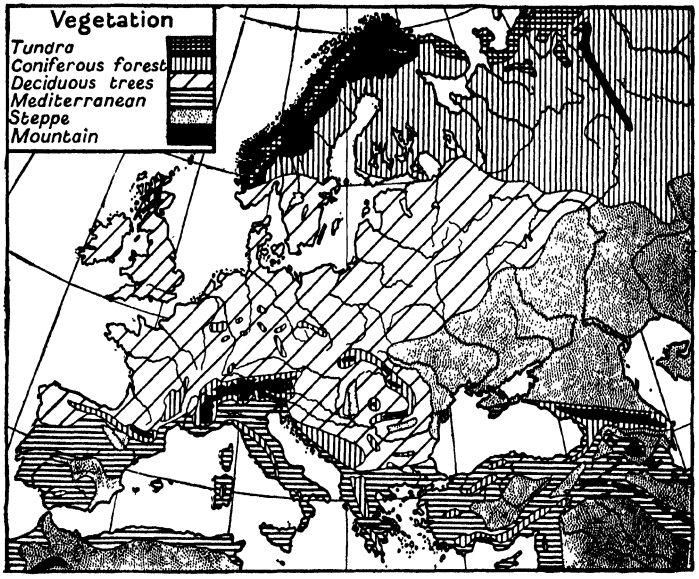


Fig. 101. Vegetation of Europe.

and prolonged winter frost, and a scorching, dry, summer heat, instances the opposite extreme in its steppe. In this way may be distinguished an Atlantic or oceanic fringe, a western European margin, a central European tract, and an eastern European region.

In respect of heat and cold and of their action on vegetation, the western fringes, in conformity with the

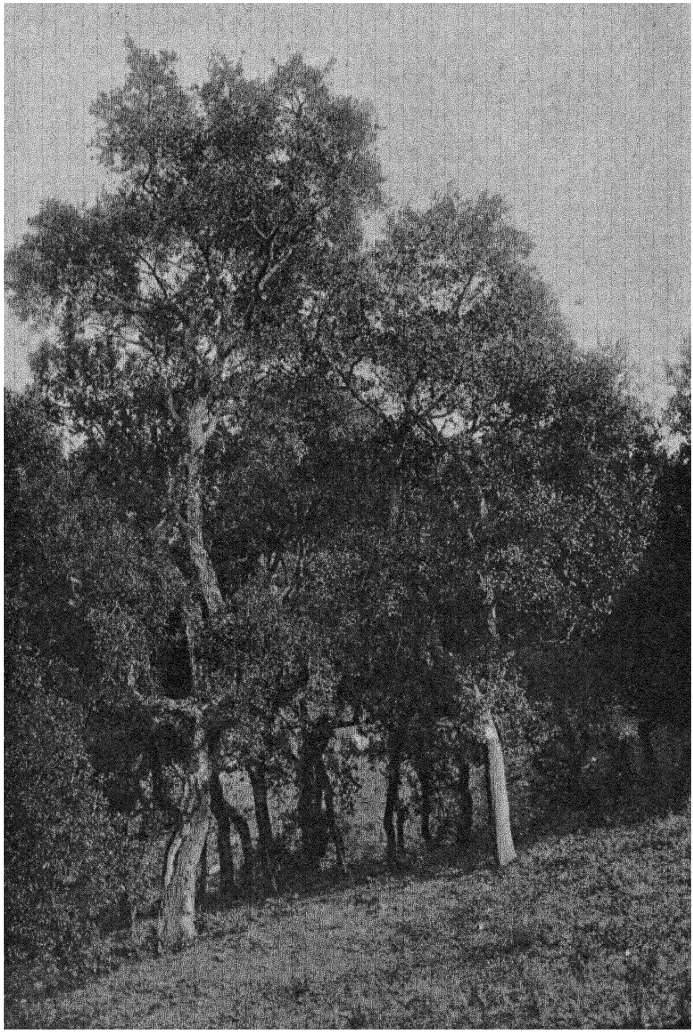


FIG. 102. Clump of Cork Oaks in S. France.

trend of isotherms, stretch in a general meridian direction. Farther east, with the weakening influence of the westerly breezes, the distribution of warmth tends more and more to conform to latitudes: hence a broad division into cold, cool temperate, and warm temperate, belts which find their expression in the coniferous, the broad-leaf deciduous, and the evergreen hard-leaf forests. In the northern region the shortness of the vegetative period excludes the broad-leaf deciduous, and leaves the ground to the spare and gaunt conifers, with their enormously reduced and wholly protected green surface, ever ready to work when the weather permits, and with their store of reserve-matter in the soft wood. In the southern or Mediterranean region, the brief duration of the period of intense growth and the general unfavourableness of the greater part of the year, due to winter colds or summer droughts, limits the broad-leaf deciduous vegetation to abundantly watered areas. The larger portion of the land supports a stout, well-protected, non-luxuriant type: the woody evergreen with a spare and leathery foliage.

In the northern region, the strip of coast open to the Arctic winds is clear of tree-growth and is clothed with low brush and moors: this constitutes a distinct belt of tundras. The passage from the coniferous to the deciduous belt is very gradual and is obscured by the influence of soils; but the boundary between the cool temperate and the warm temperate regions, i. e. between the deciduous and the mediterranean vegetations, is defined by mountain ranges such as the central plateau of France, the Alps and their outspurs in Illyria, and by the Rhodope range.

If differences between the east and the west of Europe are observed in the vegetation of the northern coniferous

and southern or Mediterranean regions, they are still more apparent in the deciduous zone of central Europe. Such distinctions are, of necessity, more subtle than between the latitudinal belts of vegetation. They do not materially affect the general aspect and composition of the large masses of forests, but show themselves in the comparative abundance of certain growth-forms and plant formations, or again in the varied forms, vegetative habits, and modes of life of the same plant species in the various districts.

In the west, the mild winters allow plants to retain their foliage longer than in the east; the periodic phenomena of plant life are not so regular nor so sudden. Life is perhaps less exuberant in summer, but the period of rest is not so complete and universal. As the advent of autumn is more gradual and slow, so the spring reawakening, as a whole, takes place earlier. With the weakening of the seasonal rhythm, there is a tendency to a prolonged, if less active, growth period, to a sort of tender-leaf evergreen of the cool temperate type. In this respect western Europe bears some relation to such cool-temperate evergreen regions as southern Chile or south-western New Zealand and Tasmania. This is especially the case for the oceanic fringe of coasts and headlands, from Ireland to Spain, where evergreens of more or less thin foliage, like the strawberry-tree, the cherry laurel, the Portugal laurel, the holly and the yew, develop best. In addition, a large number of mediterranean leathery-leaf evergreens survive the winter and are extensively planted, and there is a marked tendency to the evergreen habit in certain shrubs which, in the east, are frankly deciduous.

The contrast between the east and the west is more striking in the grass formations than in the forests and

shrubs. In eastern Europe, outside the lush meadows of the rich alluvial valleys and the subalpine and alpine regions, the grass tracts are, as a rule, of the dry and spare type of the steppe with narrow, hard, and wiry leaves. To the climate of western Europe are due the extensive evergreen carpets of succulent grass with thin, broad leaves, which reach their characteristic development in the British Isles. At a short distance from the Atlantic shore of the continent the grass begins to turn yellow-grey and to wither in winter and in the height of summer. The meadows, common to eastern and western Europe, are determined, as a rule, by the abundance of water in the rich soil. Thus the geographical significance of the two types of grass carpets in the west and in the east is entirely different. The dissimilarity of appearance, requirements, and habits connotes a fundamental divergence of physical environment. Also indicative of uniformly cool and rainy climates, and to be found extensively in western Europe as well as in the north, are the high moors or peat-bogs which occur on badly drained soils and in impure waters, and disappear gradually eastward. The heather moors, characteristic of poor soils, are again plentiful in the west and in northern Germany, but fail in the east.

In Europe the relations between vegetation and its physical environment are obscured, as in China or India, by the removal of the primitive plant-covering and the alterations undergone by the soil, and even the climate, in the course of centuries. The well-kept woodlands of these countries bear but a distant relation to the primeval wildernesses of forest, undrained, strewn with mires and swamps, packed with a thick undergrowth, encumbered with dead trunks and stumps, littered with decaying branches, and padded with mosses and ferns.



FIG. 103. *Pinus pinea*, S. France.

Such forests only allowed settlements on the margins of the valley meadows, and made even the barbarians pause and go round.

The areas of grass pastures, heather moors, and peat bogs have been changed and generally extended and the surface altered beyond recognition. Some portions have been drained, others submerged, others again irrigated or put beyond the reach of floods. Most parts have been cleared of timber, many given up to cattle and sheep, many again burned yearly, whilst a large area has been claimed by cultivation. Similarly the composition of forests, bushes, and grasslands has been altered, by fire or by grazing. A large extent of waste and derelict land has been created, whose variable and heterogeneous plant carpet, drawn from the adjacent formations, strives for some kind of organization and balance. Numberless species of plants have been imported by man, sometimes competing successfully with the original denizens. Ultimately, it is apparent that by altering the equilibrium of the animal world, destroying many species and introducing others, the nature of the plant carpet has been indirectly but powerfully affected. It is therefore difficult to do more than briefly to indicate the more obvious correspondences between the vegetation and its regional environment.

In the middle of the deciduous belt various subalpine heights form insulated areas of conifers. On the Pyrenees, the Alps and the Carpathians, the coniferous districts enclose cores of alpine vegetation.

The Arctic Region. The most unfavourable conditions offered to plant and animal life are found in the ice and snow-fields of the arctic and alpine regions. An intense frost and darkness during nearly a half of the year, alternations of frostbound earth and icy water during the

remainder, such are the conditions to which organisms must adapt themselves. Yet even the hostility of such an environment has not proved too much for the powers of endurance of plant and animal life. Seventy-two plant species, in addition to many species of animals, are able to live and reproduce on snow and ice. They are reduced to the most elementary forms, hardly more than drops of

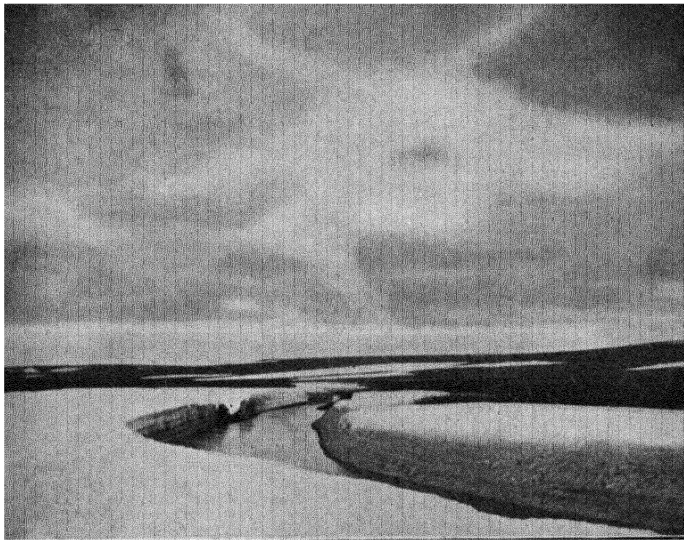


FIG. 104. Snow-bound Tundra

living matter finding their powers of resistance in the nature of their own substance rather than in adventitious means of protection, for of external devices such as higher forms of life are able to evolve, there appear to be few or none. Living things are reduced to a powdering of tiny cells penetrating the snow to a depth of one or two inches. The bright colours, rose, red, purple and

brown, assumed by the algae are ascribed to the production of substances apparently destined to absorb heat, and sanction the names of red, brown, yellow and green snows given to colonies of such hardy organisms.

Arctic-Alpine Tundras and Fjelds. Arctic conditions such as make tree-growth, and even shrub-growth, impossible are only found in Europe along a narrow strip of coast facing the polar seas. This is due to the comparatively low latitudes of the northern shores and to the moderating influence of the south-westerly winds which penetrate far into the Arctic Circle. The immediate shores of the frozen sea, deprived of the benefit of those winds by the lofty barrier of the Scandinavian Alps, and bearing the full onslaught of the circumpolar winds, alone possess a climate severe enough to preclude the extension of the hardy northern trees and shrubs.

The most telling features of the arctic climate are the shortness of the vegetative period, which is reduced to two or three months in the year, not so much by the long winter night as by the freezing of the ground and the icy and drying winds. Those features are reflected by the usual characteristics of the tundra belt: the absence of arboreal vegetation; the shortness of growth in length of the shoots and internodes; the consequent crowded foliage close to the ground; the strong development of the underground root-stock, woody or fibrous, which serves as a store of reserve materials; the thick, compact, and leathery nature of the foliage, and its reduction in size; the frequent provision of a woolly covering on the leaves; the vivid colours of herbaceous shoots due to the presence of heat-storing substances; the bright coloration of the blossoms associated with the duration of the long summer day; and a wealth of finer devices both superficial and internal. The tundra also

shelters a small number of tiny and tender annuals which accomplish their life-cycle, from seed to seed, in the space of a few weeks.

Rock, rubble, and parched clay floors in exposed situations, destitute of snow in winter, offer the scantiest vegetation. It may be a coat of crust-lichens or a sparse dotting of pigmy undershrubs and perennial herbs; often, however, the ground is left bare. These ultimate expressions of plant-life under most unfavourable circumstances penetrate farthest north and are the pioneers of the higher plant-world.

Vast carpets of shrubby lichens, interspersed with crawling junipers, dwarf berry-bushes, and other creeping under-shrubs; in comparatively quiet and sheltered surroundings even low shrub-heaths; marshes of reeds, rushes, sedges, cotton-grass and coarse grass growing on the silt of the margins of the streams; beautiful oases or bloom-mats on the southern slopes of hillocks at right angles to the rays of the low sun, all aglow with gorgeous flowers; these form the more luxuriant aspects of the tundra.

The European tundra is characterized by an abundant development of moss-heaths or moss-swamps, dreary moors formed by vast accumulations of half-decomposed peat-moss remains in the shape of gigantic, spongy, rounded cushions and mounds, sometimes from 10 to 18 feet high, with a labyrinth of intervening puddles or gutters, choked with snow in winter and submerged in summer. Mosses are particularly fitted to withstand the dry conditions obtaining on these peat hillocks on account of their capacity of drying up and reviving again rapidly under moisture, and of their hardy nature. The nearest approximation we have to moss-tundras is the peat-bog, common in Ireland and Scotland; but the formation of

peat in the Arctic region is not so rapid, extensive, and perfect as in milder countries, chiefly by reason of the shortness of the vegetative season. Moreover, the peat-moss, or *sphagnum*, and the ling, so common among our tracts of peat-bogs, fail in the Arctic. The moss-tundra disappears, going farther north, and is characteristic only of the subarctic district.

In the tundra the gastronomic resources are reduced to their minimum. A scanty supply of berries, a meagre soup of reindeer-lichen, a few roots, and an occasional salad of *cochlearia* are all that can be expected. Fortunately the reindeer, besides its hardiness and its unique aptitude to cross the moors by reason of its broad hoofs, exhibits a remarkable faculty for turning lichens into food. Hence it becomes a most valuable asset for the natives who are obliged to leave it to find its own fodder, while they wander after the half-wild herds, and depend largely on the milk, skin, horns, bones, and flesh, for a living.

Physical conditions very similar to those of the tundra extend far south on the ridges of the Urals and the summits of the Scandinavian Highlands, the ultimate outliers of which may be encountered in the broad table tops of the Scottish Highlands. Despite the now regular alternation of day and night, the vegetation of these arctic-alpine plateaus possesses, on the whole, the same features. The name 'fjelds' connotes, in Scandinavia, this type of physical and plant scenery. Above the last birches which here, as on the polar side, form the upper limit of the forests, occurs a grassy brush of low undershrubs, with small and leathery-leaved dwarf junipers and birches, crowberries, cranberries, &c., often over a carpet of mosses and lichens. Beyond 4,000 feet this is succeeded by a close mat or rug of yellow-grey shrubby

lichens, and higher up again they are more and more interrupted by plantless rubble screes which ascend to the snow-line.

Northern Europe. The region of vast forests of conifers includes most of Scandinavia, and Russia north

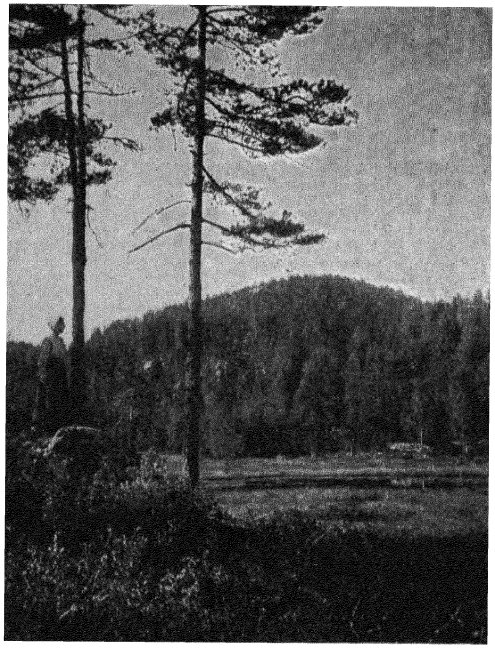


FIG. 105. View in Southern Norway—the typical northern forest of Europe.

of a line extending from the head of the Gulf of Finland towards the mouth of the Vyatka. The exclusion of summer-green broad-leaved forests seems to be determined largely by the shortness of the vegetative season as marked by the correlative duration of continuous frost which here averages five months. Of rainfall there

is a sufficiency throughout the year and the atmosphere remains fairly moist, chiefly, perhaps, by reason of the low temperatures generally prevailing. The biting, dry arctic winds become here more moderate, and there is an abundance of snow on the ground in winter; but the uncertainties of the early and late growing period limit still more the actual time available for the development and work of the broad leaves, whilst the night frosts, which occur at the beginning and towards the close of the period of growth, endanger their very existence. Ultimately there is hardly time enough for the maturing of the fruits of the temperate vegetation as we know it in central and western Europe. As climatic conditions become more severe, the number of tall trees able to withstand them is necessarily much reduced. Hence the uniformity of northern forests, where, contrary to what occurs in warmer latitudes, a single species, or two or three species, may prevail exclusively over extensive tracts of country.

The chief timber species are, in the western districts of Scandinavia, the Norway spruce, the European larch, and the Scots pine, to which in the eastern part of northern Russia, east of the Ladoga and Onega lakes, the Siberian spruce and fir, the Siberian larch and the Siberian stone pine are added. Thus as we go eastward the variety of coniferous forms increases. The spruce generally thrives best in moist situations and on heavy soils, while the pine and the larch are not so particular in their requirements, though they do not grow so well in damp surroundings. Among the very few hardy summer-green trees that accompany the conifers in these northern regions are the white birch, the aspen, and the rowan. Indeed, a stunted form of birch constitutes low woodlands in a broken belt north of the limit of conifers:

alders may occur in river thickets. Under the heavy canopy of dense spruce forests, the persistent semi-darkness tolerates on the mat of dead needles but occasional carpets of mosses and lichens, while the lighter cover of the pines and larches admits of the existence of a uniform brush of low woody and straggling bushes with inconspicuous flowers and small, leathery leaves, and of low, herbaceous ferns. There are no lianas; even climbers are rare and small, and epiphytes are reduced to mosses, lichens, and an occasional fern.

Though forests occupy the largest portion of the land, especially in Russia, a considerable space is claimed by other forms of vegetation; on the margins of the rivers are different kinds of meadows and moors; on alluvial silt flats, reed-, sedge- and rush-marshes; on wet grounds, thickets of willows, alders, &c. Depressions and badly drained areas are the seat of extensive peat-bogs or high moors: indeed, it is in damp and cool northern Europe that the greatest accumulations of peat are found. Not infrequently, waste lands, either natural or artificial, are covered by moors of low shrubs, similar to our heather-moors, with an abundance of berry bushes, heather, and bracken.

Only a very few kinds of small-leaved trees, and those extremely hardy, represent the deciduous components of such forests. Fair-sized willows are chiefly restricted to damp and sheltered situations: those growing in the open are stunted and often straggling. Large-leaved herbs are limited to meadows and are chiefly perennial, probably by reason of the shortness of the growing period: annuals are rather scarce and small: tubers and bulbs are rare. The food resources of the forests, moors, and morasses are limited to a few berries and roots; large fruits cannot withstand the raw and chilly climate,

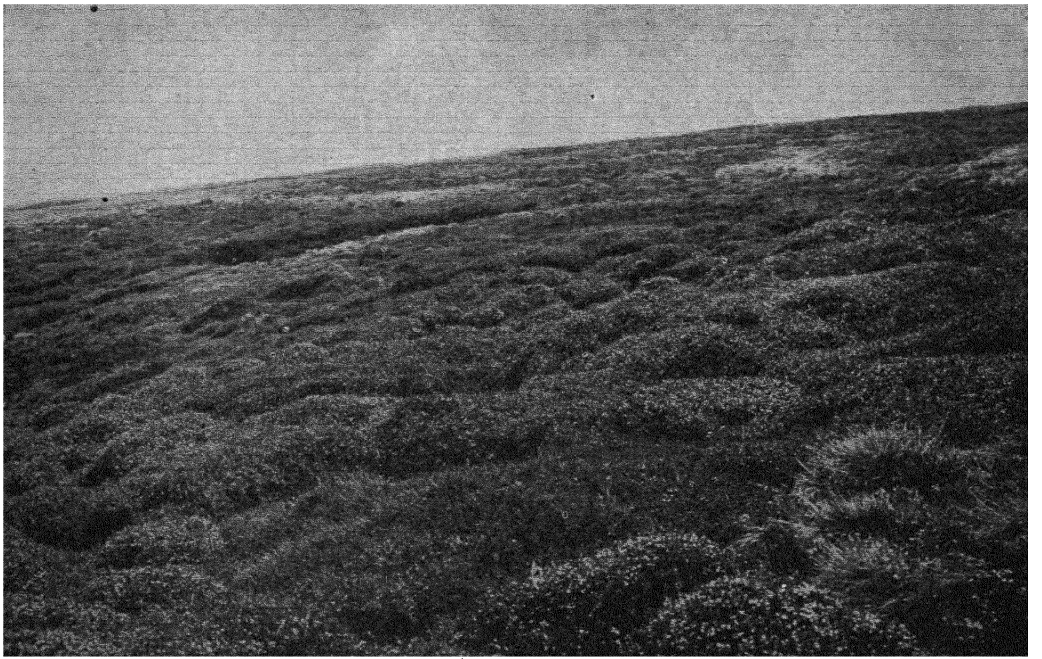


Fig. 106. Bilberry Moor.

and have no time for maturing. Of cereals, only oats, rye, and barley can be grown in a few favoured spots: the potato is grown locally. The soil of the northern region, largely of glacial origin, is poor and cold, and therefore unsuited for agriculture.

The population being reduced, outside mining, to the industries connected with hunting, fishing, lumbering, and transport, is, of necessity, very scarce, but also very hardy and industrious. In some parts, as in Finland and Sweden, the meadows, which occupy clearings in the vast forests, support a flourishing dairy industry. In Norway, pastoral activities are limited by the steepness of the mountain sides, and the impossibility of utilizing them for cattle or sheep.

Russian Steppe. Forest growth ceases altogether and gives way to the steppe or dry grass-land when the annual rainfall is below 20 inches, and there is a cold and dry winter and a hot summer. The conditions which accompany and largely determine the appearance of this new landscape are now well known: a scarcity of rainfall and atmospheric moisture; a fairly abundant precipitation in spring; a period of growth limited, on the one hand, by two to four months of frosty weather and, on the other, by two months of excessive heat; in winter as well as summer, a dry atmosphere. Such circumstances, if they allow a low vegetation of grass and herbs, are not favourable to tree growth; but to the direct climatic influences must undoubtedly be added the resultant conditions of the ground.

The Russian steppe is the westernmost extension of that vast belt which crosses Asia between the northern forests and the central deserts. It covers low, level, or gently undulating plains, in which the main, if not the sole, diversity is afforded by the succession of the seasons.

The steppe may be formed upon various soils, such as sand, loess, and clay, but the chief feature of South Russia is a deep and fertile cover of fine loam, formed by the accumulation of dead and decomposed vegetable matter, known as 'black earth' or chernozyom. The conditions of the soil, its porosity, depth, fineness, chemical and physical nature, and its proportion of organic matter, control the various details of appearance and composition of the steppe. The main part of the vegetation consists of short tufts of grass which very seldom form a continuous sward like that of our lawns or meadows. Those grasses have generally narrow, stiff, dull green or bluish leaves, wiry, curled or rolled in along the edges. On the black earth, sheep-grasses and *koeleria* predominate: on less generous soils, feather or thyrsa-grasses spread a silvery sheen in early summer. Among these tufts of grass, however, numerous kinds of low herbs, short-lived annuals, perennials with stronger tap-roots, bulbs and tubers, and even under-shrubs, cropping up at various times of the year, are profusely interspersed, their abundance being determined entirely by local conditions of soil and drainage.

After the dreary winter, the first awakening is announced by a magnificent blossoming of bulbs and tubers, among which are fritillaries, garlics, squills, gageas, tulips, irises, pheasant's-eyes, and corydalis. Early summer, with its changing skies, exhibits equally glorious sights, such as boundless fields of blue flax, red poppies, clovers, nonsuch, milk-vetch, yarrow, hedge-mustard, and many others. With the coming of the hot weather, under dazzling skies and a scorching sun, when the overheated atmosphere is all aglow with fantastic visions, mirages, and *fata morgana*, all delicate plants die out. The glamour of spring vanishes, and a grey,

yellowish tint invades the whole landscape, which assumes the aspect known as the 'buryán'. Now only stronger plants, one to one and a half feet high, can withstand the drought, such as various kinds of spreading thistles, wormwoods, and knapweeds, among which the flowers of the spikenards, larkspurs, eryngos, echinopses, and mallows can hardly throw a little brightness; but even these wither under the continuous drought. Dead stalks, flower halms and straw turn a darker and darker grey, and at the outset of the bad weather, the vast silent plain appears uniformly dead. In the sunk valleys, below the broad levels and in the depressions of the rolling downs, patches or fringes of river woods present the familiar aspect of broad-leaved, summer-green, temperate trees: poplars and willows are the dominant notes of such oases.

The steppe is the typical pasture land and supports large herds of cattle and horses, to which are added sheep and goats. Under irrigation, however, the 'black earth' has proved to be of immense fertility, and pastures have slowly retreated before the cornfields and the sugar-beet, much as in the case of the Argentine Pampa and South Australia. The chernozyom reaches the foot of the Caucasus down to the Caspian Sea; but the steppes around the Black and the Caspian seas, on sand, loess, or clay, are not so fertile and retain their pastoral life. Around the Caspian Sea, especially, the soil is mostly salt and the grass steppe gives way to the vermuth or wormwood brushes similar to the 'sage-brush' of western North America. These brushes form arid wastes whose scattered, silver-grey or hoary bushes, two feet high, showing the bare soil between them, impart a dull appearance to the whole scenery. Even in May, the uniform dark-grey tone is not brightened by the gorgeous

colours of the steppe. Other salt bushes accompany the wormwood, but often large tracts are left entirely lifeless. The steppe extends on the west to the foot of the Carpathians and stretches north to the forest-belt. On the indented edge of it, the deciduous forests consist almost entirely of oaks, with a rich scrubby undergrowth: in many places, the hornbeam forms an irregular belt of dense thickets crowded with thin, slender trees.

Hungary. Like the Russian steppe, Hungary is a region where the moderate rainfall, the dry and cold winter, the dry and hot late summer, the strong winds, and the prevalent dryness of the air are unfavourable to tree growth. The climate of this broad depression is one of extremes, owing to its central situation in Europe, as well as to the circle of lofty mountain-ranges which shut out most of the external modifying influences. In mid-summer, the leaves of the trees and shrubs wither in consequence of the great heat, drought, and consequent evaporation; the crops turn yellow prematurely, and grass completely withers in the meadows. Hungary is thus an outlier of the great steppe, whose climate, and conditions of plant-life it largely shares, though in a less accentuated form. On the margins of the rivers, the usual river-woods, reed- and sedge-swamps and flood meadows are found. The steppe, called here 'puszta', and covered with waving feather-grass or close, tall tufts of golden-beard grass, is, in places, dry enough to give rise to sand-dunes often covered with low, dense, greyish-green swards of dry grasses. Salt tracts are frequent, especially in the eastern portion, and are distinguished, according to local conditions, by salt meadows, i.e. dense, low mats of perennial herbs, or by salt steppes showing scattered tufts of blue-green waxy herbs or undershrubs. In places, the appearance of these salt depressions, dotted

with a meagre sprinkling of succulent salt-bushes, is almost identical with that of the Algerian shotts. On the edge of the steppe are to be seen frequently deciduous scrubs of thorny or prickly bushes, not unlike the common blackthorn or the juniper. These establish a transition to the forests of oaks which surround the grass-lands.

Apart from its pastures on which especially fine horses are bred, the Hungarian plain has been largely laid under cultivation and is noted as one of the granaries of the world. The dry, sunny hills, covered by a rich carpet of feather-grass, have been utilized for vine-growing and yield a famous wine (Tokay). The lowlands and foothills which encircle the puszta display the characteristic vegetation of central Europe. The oak forests which partly clothe them offer the same types as our own, but in a much greater wealth of species and a larger variety of forms. They are mixed with forests of black pine, with lush meadows and other varied formations. Behind this belt of lowland and forehills rise the wooded highlands of the Alps and Carpathians.

Balkan Peninsula. North of the Rhodope range the Balkan lands offer a type of climate and vegetation intermediate between those of the Mediterranean, central Europe, and the steppe; indeed the three types of plants of the steppe, the Mediterranean, and the cold temperate forests struggle here for predominance.

The broad, low valleys, especially that of the Danube, display much of the steppe character. Apart from the river-woods and lower swamps, the steppe still largely clothes the plains, intermixed, now with flood meadows, now with dry sand prairies. The natural pastures determine the occupation of the inhabitants, but the more fertile parts offer a scope for the growing of hemp, beet-

root, and various other vegetables. Forests are deficient in the lowlands and on the lower hills up to 1,500 feet. Clumps of mixed deciduous woods, dominated by the manna ash, represent the tree vegetation. Among the lower uplands and foot-hills, cultivation includes the vine, tomatoes, sugar- and water-melons, and southern fruit-trees such as peach, apricot, almond, and mulberry.

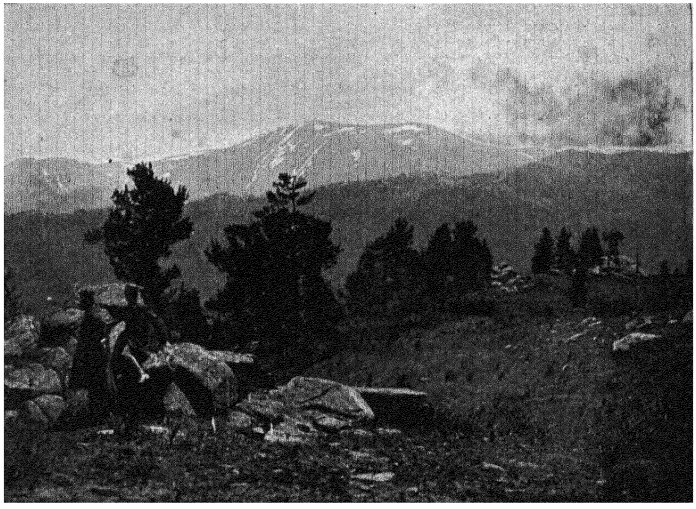


Fig. 107. Characteristic vegetation—Serbia.

About 1,600 feet above sea-level, broad-leaved, summer-green trees, mostly oaks, intermixed with black pines, walnuts, &c., begin to close in regular forests of some extent. Maize and wheat, tobacco, apple, plum, and walnut are grown in this belt, which reaches up to 3,600 feet.

Among the highlands proper, the vegetation of oaks and black pines gives way to true mountain forests distinguished, as in central Europe, by heavy mixed masses

of beeches and fir trees; and interspersed with mountain pastures, meadows, and moors. Conifers form the upper tree belt and are followed by a strip of elfin woods of dwarf pines and other shrubs. The usual alpine carpets commence at 6,500 feet and extend to the summit.

Caucasia. The region comprised between the Black Sea and the Caspian, and between the steppes of Russia and those of Persia, is extremely diversified alike in its relief, climate, and vegetation. Thrown as a steep and lofty barrier athwart the path of the south-west winds which sweep across the Black Sea, the Caucasus range causes a heavy precipitation, which in the west reaches over 80 inches yearly, and gradually dwindles to 20 inches towards the east. This rainfall is spread with a fair regularity throughout the year. At the same time the conditions of temperature, at least in the lower parts, are warm or temperate with a mild winter. Caucasia has a climate analogous to that of western-central China, especially in the mountain district, or again to that of the southernmost Appalachians.

Such ideal circumstances make the Caucasus essentially a land of heavy and dense forests contrasting sharply with the surrounding arid areas. The development of warm temperate evergreen rain-forests is opposed by the temperature minima of the winter and the scarcity of rain in the autumn. For these reasons and owing to the well-defined seasonal rhythm, the forests remain of the broad-leaved summer-green type, like those of the northern slopes of the Elburz. The centre of the greatest luxuriance is to be found in western Caucasia, in a lower belt along the eastern shore of the Black Sea. Europe possesses no region of richer profusion than the ancient Colchis, well known from earliest times for its indescribable beauty. Another distinctive feature of its

forests, and one which denotes at once a more generous climate and a less troubled history than those of western Europe, is the variety of forest trees and shrubs. With the several kinds of oaks, hornbeams, plane trees, chestnuts, walnuts, lime-trees, beeches, maples, horse chestnuts, cherry trees, cherry laurels, with an admixture of several Mediterranean representatives such as the laurel, fig-tree, and sumac, of varied conifers such as pines, firs, and spruces, and their wealth of beautiful shrubs, vines, and climbers, the west Caucasian forests, often impenetrable, avoid the monotony of those of western Europe and, to a certain extent, recall the conditions prevailing over the south-western part of the continent prior to the onset of the Ice Age.

Rising towards the central range, one notices the disappearance, one by one, of the more delicate species of trees and shrubs and the gradual change to the more monotonous aspect of our western forests, until conifers alone remain; but there is ample compensation in the development of exuberant meadows with grass 6 to 7 feet high. They are packed with many tall and strong herbs of broad and delicate foliage and profuse flowering. Above the conifers, at 6,500 feet, extends a belt of shrubs, richly blossomed rhododendrons, cotoneasters, &c., which lead up to the shorter-set but scarcely less beautiful alpine meadows and pastures, abundantly watered by the snow-fed torrents and the mists.

Quite different is the scenery of the eastern half of the range, which is much drier, and where woods play quite a secondary part. The northern slopes, even in the west, are more uniformly, less profusely, wooded. The broad-leaved forests are mainly composed of oaks with an undergrowth of hazel, for conifers do not extend over the eastern portion of the range: indeed, woods seem to

be mostly of local occurrence on the Caspian slopes. They are replaced by thickets of a thorny bush, the poliurus, which form a sort of maquis.

The little Caucasus, south of the Kur valley, and the complex ranges of northern Armenia share only to a limited extent in the luxuriance of the western Caucasus: what remains of their forests is of a mixed deciduous and coniferous type, more or less scattered and with but a scanty undergrowth. The Caspian valleys are increasingly dry towards their mouths and largely deforested, and the steppe penetrates far into them; but agriculture is carried on, even in the lowlands of the Kur valley. This region, being situated on a natural route from the east to the west, and sheltering many vanquished races in the fastnesses of its rugged and difficult mountains, has suffered greatly from the wars and petty struggles that have gone on for centuries, with the result that many of its forests have entirely disappeared: while the agricultural populations made inroads on them from below, the pastoral population of the plateau and upper slopes destroyed them from above. As on the Mediterranean, the forests have been reduced often to loose and dry wood-, brush- and shrublands.

The hilly nature of the Crimean peninsula affords it the full advantage of the moisture of the Black Sea winds and makes it, in respect of vegetation as well as of climate, an outlier of the Caucasian region, in the middle of the steppe.

Mediterranean. The region of warm temperate climate, with a mild and rainy winter and a hot and dry summer, is fairly well defined, geographically, round the shores of the Mediterranean by a barrier of mountains and highlands: the Pyrenees, the central plateau of France, the Alps, and the Rhodope range. On the east the Mediter-

ranean region is bounded by the Anatolian plateau, the Taurus, and the Syrian desert: on the south it embraces broken strips of the north African headlands such as the coast of Cyrenaïca, a coastal strip of Tunis, and the Tell of Algeria and Morocco north of the Atlas.

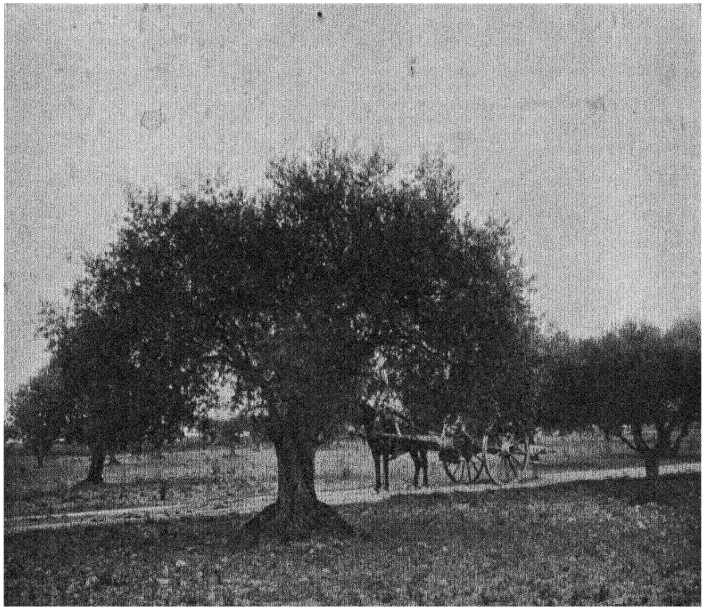


FIG. 108. Olive grove—S. France.

On such a vast and diversified area the climate naturally changes in its details, but remains fairly constant in its typical features. The mean average temperature for the year ranges from 60° to 70° F., and the annual rainfall is generally over 20 inches: there are three or four months of dry and hot weather, and the winter is comparatively mild and rainy. These conditions favour

the growth of a vegetation consisting mostly of forests, wood- and shrublands—characterized by a small-leaved, leathery, evergreen foliage; by an apparent exaggeration of the woody and fibrous portions; by a rather low stature of the trees; a general dull-green or bluish colour; the development of thorns and prickles, resins, wax, and essential oils, and other devices chiefly directed against excessive transpiration. Bulbs, tubers, and rootstocks are characteristic of this region: perennials are richly varied and often assume a woody, shrubby form. The forests do not, as a rule, attain great density, luxuriance, or height; lianas are wanting; vines are usually fibrous and wiry climbers; the undergrowth of shrubby evergreens is abundant, sometimes impassable. The most common forests are those of ilex-oak, cork-oak, stone-pine, Aleppo and black pines, firs, cypress and cedar. Frequently deciduous forests occur where the ground moisture allows it: oaks, manna-ash, plane-trees, &c., are the components.

When the forests are destroyed there springs up in their place dense scrub, 5–10 feet high, of mixed evergreen and deciduous shrubs, many of which composed the undergrowth of the original woods. On limestone grounds the scrub is generally drier and more scattered, chiefly limited to bushy evergreens, and is called the 'garique' in France. There are many varieties of such rocky heaths and low thin woodlands and brushes. Laurels, olive, fig, dwarf palms, locust-bean or carob-trees, and several others may form locally mixed or pure woods or thickets. The elm and its relative the celtis, the plane-tree, the terebinth and the Judas-tree, are also characteristic, but are mostly solitary. Of shrubs and smaller trees there occurs a bewildering variety: among the best known are the myrtle, rosemary, cistus, lentiscus, tree-heath, dwarf-oak,



FIG. 109 Live Oak Garique on limestone—S. of France.

laurustinus, oleander, and many others. Agriculture affords here most varied resources: wheat, maize, and rice, cotton and tobacco, lucerne and carob, orange and lemon, almond and fig, walnut and chestnut, grape and olive; the number of ornamental plants, trees, shrubs, undershrubs, perennials, and bulbs is even larger.

Typical Mediterranean vegetation generally extends up the slopes of the surrounding highlands to about 2,800 feet above sea-level. It is succeeded by a belt of mixed summer-green woodlands, among which oaks play a prominent part, while the cedar is a notable type in the south-west and in the east (Atlas, Lebanon, and Taurus).

The destruction of forests in this region is even more complete and extensive than in central and western Europe, and has been attended by more serious consequences by disturbing the water-supply, exposing and clearing away the soil, reducing whole mountain sides to the bare, rocky core: the whole region has been impoverished thereby and in places entirely ruined. Among those countries which have suffered severely, because the rainfall is scantier, Spain may be mentioned. Over a great portion of its surface the yearly precipitation does not reach 20 inches: the forests having been all but wiped out, the sierras have been converted into stony and rocky wastes: rain-water, instead of being retained and distributed regularly by the vegetation of the highlands, is allowed to rush away, unchecked, to the sea, so that the rivers are either dried up or in flood, and agriculture, except in the irrigated lowlands or huertas of Andalusia, Murcia, and Valencia, &c., is rendered rather precarious. Spain is further remarkable for its arid esparto grass-lands, which recall the Algerian

alfa plateau. Such areas correspond to a rainfall below 16 inches. The most important are found in the Ebro valley, in La Mancha, and on the south-east coast. The high 'Meseta' plateau, another centre of low rainfall, is equally arid and treeless.

Illyrian Karst. The Highlands of Illyria, Albania, and Greece separate the Mediterranean from central Europe. A series of limestone ranges, rising sharply from the Adriatic and shaping its eastern shore, run in a general north-west to south-east direction, forming many longitudinal terraces and scarps, deep valleys, lofty plains, stony depressions and rugged highlands; they sink gradually to the north-east into the hilly lowlands of the Save and Danube. Here the prevalence of limestone rock entirely controls the nature of the relief and largely that of the vegetation. The rock is full of cracks, fissures, caverns, and holes of all sizes, through which rain-water sinks too rapidly, leaving the surface dry. When torrential downpours sweep across the country, the overflow comes rushing down the steep slopes, washing away the loose soil and depositing it over the closed plains or 'poljes'. Scarcity of soil naturally renders vegetation both stunted and scattered, and confines it largely to valleys and terraces. These conditions of sheer slope, porous rock, and scanty soil, resulting from the soluble nature of the limestone, impart to the vegetation a much drier aspect than it would possess otherwise. According to the elevation three climatic zones may be distinguished: a lower or Mediterranean, a middle area whose climate corresponds to that of the lowlands of central Europe, and a higher mountain belt corresponding to the Alps. As features of this region are to be counted the bora and the sirocco: the former a dry icy blast sweeping down, in winter, from the snow-

clad summits and doing great harm to early vegetation; the latter, which blows from the south and west, producing, from October to December, mighty downpours which soon sink down through the honeycombed rock, choke the narrow gorges, flood the holes and closed plains, wash down the soil and humus, and work more harm than good. This specific aspect of the limestone country, with its fantastic rugged relief, fissured rock, lack of water and soil, and the arid appearance of its vegetation, is connoted by the local name of 'Karst', which applies to the western and southern portion of this region.

The most typical part of the Karst is the lower or Mediterranean belt, with its rainless scorching summer and its moderately rainy winter. Rugged cliffs and sheer slopes, with narrow ledges and terraces; stony wastes with pits and larger holes called 'dolina'; the whole seamed with precipitous gorges; desolate highlands and isolated depressions turning into temporary lakes, form its characteristic features. The woodlands, which at one time undoubtedly covered a large portion of it, having been recklessly destroyed, the slopes were almost entirely denuded of their soil, and the maquis and garigues have taken possession of the ground. They sometimes form impenetrable thickets wherein dwarf oaks, myrtle, laurel, strawberry-tree, tree- and other heaths, lentiscs, sumacs, terebinth, Spanish broom, laurustinus, oleander, paliurus, and numerous other hard-leaf shrubs, undershrubs, and perennials abound. Often, however, the plants can only form a scattered growth or rock-heath, and large stony tracts are left almost bare.

The coastal shelves, alluvia and isles have partly retained forests of black and Aleppo pines with an undergrowth of hard-leaf evergreens on the rocky ground.

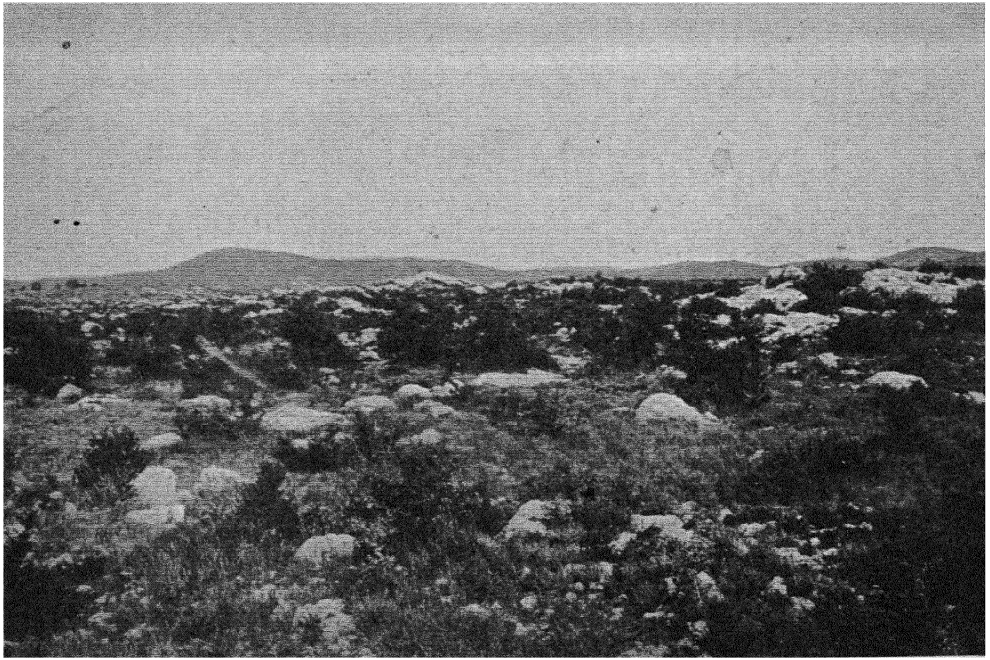


FIG. 110. A barren limestone plain, or carso—South of France.

Other alluvial parts are quite fertile when drained, but swampy when not. Above 1,500–2,000 feet the typical leathery-leaf vegetation gradually gives way to a summer-green landscape which covers most of the hill-lands, depressions, and slopes up to 3,800 feet. This is the temperate oak belt which, wrapping round the ranges of high mountains, reappears on their eastern and northern

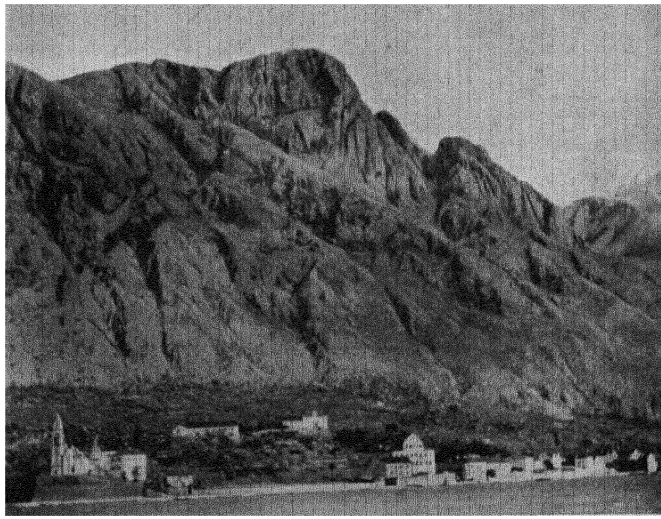


Fig. 111. Limestone slopes on the Adriatic.

sides and spreads over the uplands draining to the Save and Danube, and the middle valleys draining to the Aegean Sea. Great havoc has been wrought among these deciduous oak forests on the Mediterranean slopes, but extensive timber areas still persist on the Danube side. The karst-forest includes, beside oaks, characteristic forms such as the manna-ash, various kinds of maples, and hornbeams; it is frequently replaced by scrub,

heaths, waste lands and rough pastures of feather-grass and andropogon or golden-beard grass. Not seldom even bush and thirsty grass-lands disappear entirely: the soil is washed away and nothing is left but deserts of naked rock. The upper zone is better preserved and exhibits stately forests of mixed beeches and conifers of great beauty and a rich variety of plant forms. Interspersed among the forests and spreading into an alpine zone are to be found extensive and lush meadows and pastures: these are best represented on the outcrops of older rocks which form the core and summits of many of the inland mountain ranges.

Po Valley. Well enclosed on all sides but one by mountains and lying very low and level, receiving therefore but a scanty rainfall, and having as a consequence a rather extreme climate, the big alluvial plain of north Italy possesses conditions of soil and climate which differentiate it at once from neighbouring Mediterranean lands, but liken it to the Hungarian puszta and to the Rumanian and Russian steppe.

What appearance the virgin alluvium originally presented, it is difficult to say after so many centuries of cultivation and alteration. Certain it is that it does not bear the stamp of the typical Mediterranean vegetation; that it owes its great fertility to the abundant irrigation produced by a network of rivers and canals, and presents a striking similarity to the plain of the Ganges. Its actual tree-growth is largely of the broad-leaved, summer-green type, either planted or in river-woods. It seems probable that besides flood-meadows and marshes, dry grass-lands with a steppe character once played an important part in the natural landscape, but of these few traces are left: for these reasons the plain of the Po stands apart as a geographical unit.

Central Europe. Under this name may be described the region which includes the southern portion of Scandinavia, Denmark, and the bulk of the land east of the lower Rhine valley, of the Vosges and Jura, and north of the Alps: it stretches eastward in the shape of a wedge, between the northern belt of conifers and the Russian steppes, to the Urals.

From the Atlantic coast eastward the rainfall decreases, while the contrast between winter and summer temperatures increases. The trend of the winter isotherms lies in a north and south direction, and the lines of equal duration of frosty weather are similarly directed: for instance, the isotherm of 32° F. for January, which marks the northern limit of average winter temperature above freezing-point, runs from the west coast of Denmark and Norway a very few points east of south down to Trieste. Most of central Europe possesses over two months of lasting frosts, but summers are warm and the vegetative period is long and sufficiently damp, the yearly amount of precipitation exceeding 20 inches.

Those are ideal conditions for a dense forest growth of a cool, temperate type, and it is well known that most of central Europe was at one time heavily wooded. Deciduous trees with broad leaves are best adapted to this kind of climate, and they occur in overwhelming majority; yet the northern conifers are not excluded. Forests are of a mixed type like those of eastern North America or of Manchuria. Taking the broad lines of the respective distribution of conifers and deciduous trees, the former are characteristic of the upper slopes of the highlands, i. e. of a climate analogous to that of northern Europe: their occurrence in the lowlands, and under milder conditions, generally marks outcrops of poor and dry soils, mostly due to glacial or subglacial deposits, or again to a spon-

taneous or artificial deterioration of the soil. Again, the interference of man, mostly by cutting or burning forests for mining, smelting, for agriculture, or cattle and sheep raising, has entirely altered the original covering, and resulted in a complete disturbance of the natural state of affairs. Thus different kinds of forest have replaced each other or again have given way to pastures, moors or waste lands.

Among the predominant forest constituents, the oak and the beech stand foremost and sometimes form nearly pure communities. The beech especially succeeds in shutting out all competitors, much as the spruce does. The oak constitutes more open covers and tolerates the growth of other subordinate trees. The sweet chestnut, the birch, the ash, the hornbeam may also flourish almost exclusively in special circumstances and over tracts of lesser extent than the oak and the beech. Other still less social trees, which occur scattered or in small clumps, are the maple, the aspen, the rowan, elms and lime-trees, the gean (or wild cherry), willows, poplars, &c. The shrubs and smaller trees of the undergrowth are also deciduous. The temperate forests vary greatly in the amount of undergrowth which their leaf canopy allows. The heavier types like the beech forests, when most strongly developed, exclude all underwood except a few mould-loving species, like the lily of the valley, Solomon's seal, herb Paris, certain orchids, wild hyacinths, anemones, primroses, woodsorrel, woodrush, woodruff, or again ferns and patches of mosses. The clearings generally harbour a large number of shrubs, perennial and annual herbs, and even bulbs and tubers.

The fairly regular distribution of the rainfall throughout the year, the absence of excessively dry winds, and

the moderate humidity of the atmosphere in central Europe also favour the local development of close grass and herb carpets of the succulent meadow type, non-fibrous, tall and profuse; and also, according to circumstances, of shorter pastures presenting drier, less luxuriant types leading to the dry steppe grass-lands. In places, the contest between forest and meadow, tree and grass, is keen and, beside local conditions, man's influence has often turned the scale in favour of pasture, seldom of forest. From a comparison of virgin soils in eastern Asia and America, it seems that originally the best for the transformation of such combinations of meadows and woods, sometimes called wood-meadows, into a park scenery, are rich alluvial plains. Pastures also exhibit a great variety, not only in their composition but in their adaptations and modes of life, depending entirely on local circumstances: greatly resembling the steppe, for instance, are certain short and meagre tracts of dry, stunted grasses, carpeting limestone rocks over a thin coat of soil.

Leaf-shedding shrubs sometimes constitute lasting communities in the form of thickets, e.g. hornbeam or hazel-nut copses on sunny limestone hills, or again willow and alder thickets in river marshes; but these are of local occurrence. More important are the heather moors of various kinds which occupy large portions of poor soil areas in north-west Germany, in Denmark and Scandinavia. Again, peat-bogs or high-moors, especially in the northern portion of this region, and in the mountains, develop in badly drained localities. Marshes are frequent and varied.

It should be kept in mind that the relations between the natural physical environment and the vegetation have been infinitely complicated by the intervention of man.

Quite apart from spontaneous causes, it is now fairly certain that a large extent of such peat bogs covers the former sites of forests. A considerable portion of the North German heather moors has taken the place of forests of conifers: the manifold varieties of pastures have similarly replaced other vegetable coverings: again cultivation has extended over former timber grounds or natural meadows, or over former swamps. Doubtless the later or secondary developments of the original plant cover and the uses to which it was put by man were largely determined by the double influence of climate and soil; yet even the nature of both has been so profoundly altered in the process of utilization that it becomes increasingly difficult to unravel the tangle of actions and reactions which have been at play.

Western Europe climatically is distinguished from central Europe by its milder winters, during which frosts are only temporary; by a somewhat greater and more regularly distributed rainfall; by cloudier skies, and a moister atmosphere. The vegetative period is thus longer than in central and eastern Europe, while the summer is also somewhat milder than farther east. It is generally a region of subdued features, large plains and gentle uplands, and for these reasons the vegetation lacks the variety which obtains in central Europe. Most of England belongs to this region. It is essentially a land of oak and beech forests and of green pastures and meadows. Conifers are remarkably lacking, except the Scots pine in Britain, the common juniper, and the yew. They have been introduced extensively, but never constitute, in the wild state, pure or mixed forests. The westernmost coniferous forests are to be found on the line of the Venns, the Vosges, Jura, and western Alps, on the central plateau of France, and on the

Pyrenees, barring the woods of maritime pine on the south-west shores of France.

The greater portion of the forests have been cleared for cultivation and grazing. They include mostly mixed



Fig. 112. Arundel Beeches.

deciduous types, of which the beech and the oak are the chief constituents, and sometimes form pure woods. River woods or marsh woods consist of poplars, willows, birches, ashes, rowans, alders, berry-bearing alders,

with a great development of large-leaved herbs and climbers. In England, the Scots pine generally marks poorer and drier grounds, such as sand or gravel or moors. There are few shrub formations. The thickets of sloe or sea-buckthorn on rocks or sandhills, or brushes of gorse and broom are well known; and on dry limestone hills, with a thin layer of soil, may be found copses of hornbeam, blackthorn, juniper, bramble, brier, hazel-nut, dogwood, hawthorn, guelder-rose, either mixed or in separate colonies, over a carpet of sheep's grass. Amongst lower brushes may be counted the heather, usually associated with sand or peaty or other poor grounds devoid of lime; or, again, succulent salt-bush brushes in salt marshes near the sea. Herbaceous vegetations offer a fairly large variety, from the tall reed-swamps, the rush-, sedge-, and meadow-marshes, to the regular meadows and pastures of different kinds. Under the name of moors may be included grass moors, heather moors, or mixtures of both; or, again, brushes or brakes and other more or less indefinite waste herbage. The peat bogs formed by the accumulation of dead remains of several kinds of mosses, chiefly of the sphagnum-moss, do not occur so plentifully in this region as farther north, in the belt of coniferous forests. A more frequent form of marsh is the meadow-marsh or low moor in which the water is moderately rich in lime and characterized by rushes, reeds, sedges, and coarse grasses.

The largest areas of peat bogs are to be found in an intermediate zone between western and central Europe on glacial, ill-drained soils, in the north of Holland, the western German plain, and Denmark. Low marshes predominate in the fenlands and the corresponding tracts of polders in Flanders and Holland. Heather moors are often associated with peat moors.

Western Europe was probably less extensively and densely forested than central Europe. An abundance of rich grass of the succulent type was—and still is—a feature permitted by the moderate and uniform climate: wood meadows and valley meadows are combined with timber in a pleasant park landscape. There was more ground directly available for the rude implements of the early agriculturist and more room for his cattle; indeed, in the course of history, the mild climate, the bountiful alluvial plains, and the lush grass of the graceful wolds exercised almost as great an attraction for the eastern invaders emerging from the sombre central European forests as the Mediterranean itself.

South of this region rises the central plateau of France, which in respect of climate and scenery, as well as of vegetation, bears a great resemblance to the highlands of England and Scotland.

Atlantic fringe. The most temperate region of western Europe is naturally found on the oceanic fringe, open directly to the moderating influence of the southerly, south-westerly, and westerly winds. This fringe includes a narrow coastal strip of south-west Ireland and England extending eastward to the Isle of Wight, and in France wraps round the point of Britanny. It covers also a widening strip south of the Gironde to the Pyrenees, the seaward slopes of the Cantabrian and Asturian barrier, and the coast ranges of Spain and Portugal down to Lisbon.

In this region of narrow climatic ranges and weak seasonal rhythm, plants have a greater freedom as regards the times of passing through the periodical stages of their annual growth, which are performed more in accordance with the particular bent of each species or even of each individual: the setting in of

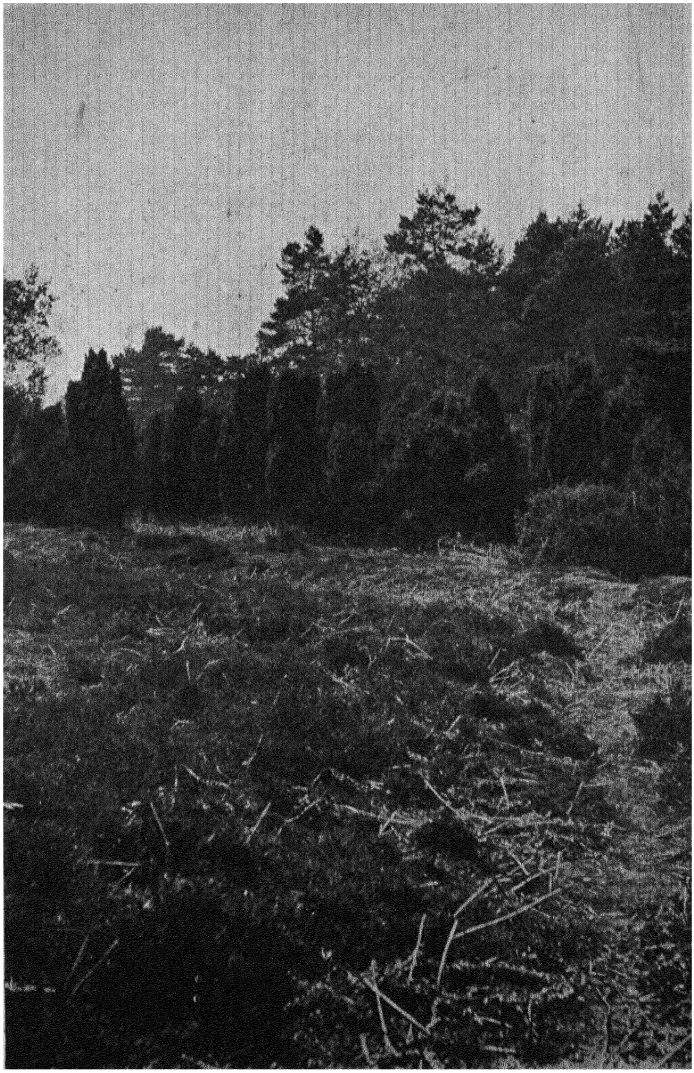


FIG. 113. Pine Wood—Surrey.

the autumnal rest, as well as the reawakening in spring, are spread over longer periods; the leafy stage is also somewhat prolonged. Hence, the whole plant world gives an impression of evergreenness, and in many cases there is a real tendency thereto. This is especially noticeable with the lawns and pastures, which preserve throughout the winter an ever-fresh appearance, but it is not lacking among the shrubs of the undergrowth, such as the privet.

The same mildness of winter accounts for the luxuriant growth and abundance of such native evergreens as the holly, the strawberry tree, and the yew, with their comparatively tender leaves. It also explains the enormous development of such imported evergreens as the cherry laurel and Portugal laurel, the rhododendrons, ancubas, privets, euonymus, and even camellias and aralias, while in sheltered corners it permits the existence in the open of some of the hardier palms. At the same time a large number of hard-leaf evergreens of the Mediterranean are able to vegetate throughout the winter, assuming, in most cases, the broader and thinner foliage and the general aspect of tender-leaved evergreens. Among those which are most commonly seen in our gardens may be mentioned the laurel, the holm oak, and the laurustinus. Southern conifers may be thoroughly acclimatized in favourable spots: even such plants as the fuchsias, camellias, and some profuse types of delicate magnolias, intimately associated with thoroughly temperate climates, display the same exuberance of foliage and blossom as in their native homes.

As regards plant societies, the oceanic fringe of Europe has developed few characteristics of its own and does not differ from western Europe. It is important also to mention that, strange as it may appear in view of the

enormous cultivation of bulbs in this country, the bulb and tuber are not characteristic features of the vegetation of mild oceanic climates. Such forms, so obviously adjusted in respect of their stores of reserve materials in bulbs, tubers, or strong rootstocks, to long periods of rest through drought or cold and to a short period of aerial growth, are rather test plants of arid, semi-arid, steppe or mediterranean climates. They are particularly well developed in, and quite characteristic of, regions like the South African Karroos, the Peruvian semi-deserts, the Asiatic and Russian steppes, and the Mediterranean. They decrease alike in number, variety, and size, from the south-east to the north-west of Europe. On oceanic and sub-oceanic margins they confine themselves, or are possibly confined by competition of other plant forms in the wild state, to very special environments such as rich pastures, meadows and marshes, certain kinds of forest moulds, rocks, &c., where but a short growth period is available. The fact of their extensive cultivation illustrates their great adaptability and the early reawakening of nature on the oceanic fringe.

Britain. Several aspects of the vegetation of Britain have already been mentioned: the Scottish and English highlands were associated with the Scandinavian Alps as part of the North European region of conifers and birches, and the south-western or Atlantic fringe was connected with the broken fragments of a similar belt in France and Spain. The bulk of the country belongs undoubtedly to the western region of the cool-temperate deciduous belt, from which it differs in no essential respect. The landscape is typically that of western Europe, viz. an undulating park, where pastures and meadows predominate over the cultivated area, dotted

with small patches of forest, mostly of oak and beech and other mixed deciduous trees, maple and ash being the chief subordinate species.

Of the vast forests which undoubtedly once covered a large portion of the land there remains less than in most continental countries; indeed, except in some remote parts of Scotland and Wales it is doubtful whether



FIG. 114. A forest clearing planted with rye and bordered with elms.

there remains any genuine vestige. The existing woods have all been planted.

Above the plains and lower hills rise the uplands and highlands, which have also been entirely denuded of their original covering, and whose actual vegetation consists of moorlands and hill pastures. It is possible to trace four main zones of altitude: the lowest zone is that of the beechwoods and lowland oak woods; the

oak rises higher than the beech, and with the help of the Scots pine constitutes a second belt of deciduous forests poorer than those of the lower reaches and lowlands; the forest intermingles with hill pastures in a third zone, and moorlands constitute the fourth. Curiously enough, this order is the reverse of that prevailing among central European mountains where beech forests mixed with conifers occur above the oaks and mark the upper belt of summer-green, broad-leaf forests; but it is in accordance with the order of succession prevailing among the Scandinavian mountains and also with the extension of the beech and oak in latitude, when the beech stops nearer south than the oak. In this respect, therefore, the British highlands are related rather with the northern mountains than with those of central Europe.

Above the oak belt, at altitudes ranging from 700 to 900 feet, the conifers remain in almost exclusive possession of the ground to an elevation reaching, in places, over 2,000 feet; they are accompanied by the birch, and both form the tree-limit. The actual woods, however, are extremely few and scattered. Moorlands, peatbogs, and various kinds of hill pastures occupy nearly the whole of the surface, while alpine pastures, moors, and wastes occur above the coniferous or subalpine belt. The British mountains lack the larch, the Norway spruce, the silver fir, the arolla, and mountain pine. They show only the Scots pine, and, as subordinate species, the yew and juniper. Similar deficiencies are noticeable among the broad-leaf trees and shrubs, not to mention lumbler plants, which, once introduced, thrive and spread just as well as in their native countries. An early separation from Scandinavia and from the Continent before Britain was fully stocked with European plants, appears to be responsible for the absence of a number of

timber-trees and shrubs which diversify the continental mountains, and generally for the poverty of plant forms. In the lowlands, the Scots pine usually marks the occurrence of dry, poor soils such as gravel and sand, or again moor-lands; with it generally appears the heather, forming low heaths, which may be taken as connoting infertile soils, either cold and devoid of lime, or sandy and porous.

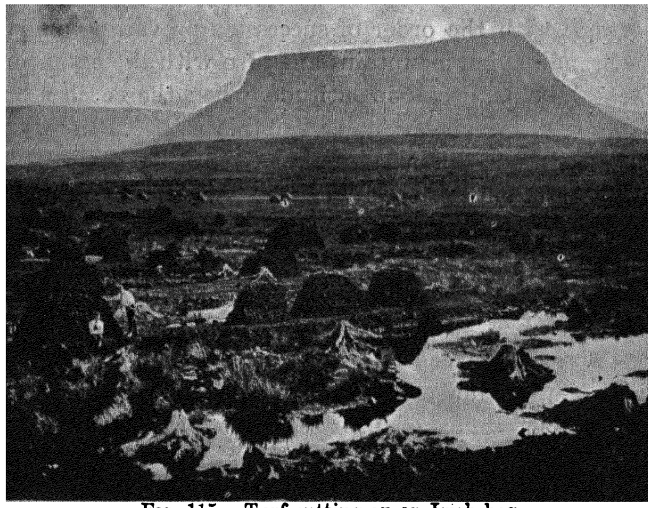


FIG. 115. Turf-cutting on an Irish bog.

The extension of moors in the plains is similarly connected with poor glacial soils in Scotland and Ireland. The wet moors, also called high moors or peat bogs, originate in ill-drained areas supplied with pure siliceous water. They are due to the enormous development of several kinds of mosses, chiefly of sphagnum or peat-moss, whose dead remains putrefy under unfavourable conditions, namely, an excess of moisture and lack of air: a similar result is produced by other plants, mainly

sedges and cotton-grass. Heather is usually associated with this kind of vegetation, which is extensively developed in the west and north of Britain and on the uplands and highlands: heavy and impervious infertile glacial clays are particularly favourable to their formation. In many cases the peat has taken the place of forests, as is shown by the remains of trees found buried in the high moors.

Another kind of moor, characteristic of the lowlands, is the fen, low, or meadow-moor which usually takes the form of reed (rush or sedge) or grass marsh. It is frequently associated with alluvial tracts, in process of formation, undrained, and provided with water rich in lime or organic deposits, such as the 'fens' or 'carses', which are represented across the Channel by the 'moëres' and 'polders' of Flanders and Holland. When they are drained and cultivated, the peat decomposes into a rich black earth which is especially suitable for market gardening.

The older rocks, which form so large a proportion of the uplands and highlands of Britain are, on the whole, of an infertile nature. This, added to the uncertainty of the weather and the difficulties of cultivation, renders them more suitable for pastures. It was largely the nature of the soil which determined the fate of the hills, after they were cleared of their timber, the poorer soils rapidly developing moors, dry grass-moors, heath-moors, &c., the better kinds giving rise to pastures. Among the best for pastures, under the moist and equable climate of Britain, may be mentioned the limestone soils of Yorkshire, Sutherland, &c.

CHAPTER VII

CONCLUSION

THOUGH the foregoing account only deals with the broad features of the natural regions of the world in a bird's-eye view, it will be at once apparent that the plant-covering does not consist of a mosaic of entirely dissimilar parts, but, on the contrary, that it offers obvious similarities and relations, a number of which have been mentioned in the course of the descriptions. Thus the vegetation of the mediterranean scenery all over the world is singularly alike, whether the Mediterranean of the old world, California, the central valley of Chile, the south-west corner of Africa, or the south-west corner of Australia, be considered. When their indigenous vegetable products are placed side by side in a conservatory, it is difficult to trace them back to different regions.

Similarly the equatorial forests all over the tropical belt, though composed of entirely different species, can hardly be told one from the other, and the landscapes of the lower Amazon, of the lower Orinoco, of many parts of the Upper Guinea coast, Borneo, or New Guinea, or again of the big Indo-Chinese deltas, are strikingly alike. The list of these obvious correspondences or 'analogies' will easily be made from the foregoing short sketches, and should now be attempted as a necessary exercise.

Nature, however, attains her ends by various means, and shows herself infinitely diverse. To apparently identical conditions of climate and soil, plants may be

adapted in many different ways: various plant communities, like plant-forms, may be adjusted with equal efficiency to similar environments. The result is a certain difficulty in bracketing together regions which from the physical data at present available we may presume are enjoying similar conditions, though the appearance of the vegetation either in plant-forms or in communities may be different. The evergreen, cool, temperate forests of the Magellan and south Chilian coast region, and the moist coniferous forests of the coast of British Columbia, are a case in point; again, the Argentine pampa and the North-American prairie; or, again, the eucalyptus park-landscapes of the hinterland of eastern Australia and the campos park-landscapes of the subtropical Brazilian highlands. In many cases uncertainty arises simply from the scarcity of reliable observations. In others, however, the dissimilarity of plant-forms really conceals a combination of different means making for an equivalent adjustment to similar conditions. Only the study of the modes of life and of the deeper-seated internal adaptations discloses the identity of purpose and final adjustment, the true *homology* of the plant-forms and communities.

It should also be borne in mind that the present plant populations of the various parts of the world have arisen from various sources, undergoing different processes of development in the course of ages. Even though physical conditions be equivalent at the present time on two points of the world, the plant materials which had to change and adjust themselves to these now identical environments may have been originally different. It is somewhat difficult, for instance, to understand why the Pacific mountains of North America should be so overwhelmingly populated with coniferous forests, without

the help of some geological reason. In other words, the processes of modification of unlike plant materials in view of the same end have been different. Starting with a different history or *heredity,* plant materials evolving towards a similar adjustment to similar circumstances have attained this same end in different ways. Assuming, therefore, an equal degree of fitness to thrive, reproduce, and spread amid equivalent surroundings, it is not surprising that the result, in point of plant-forms and combinations thereof, offers divergences. It would be bold, however, to assert that the vegetation, even as it is now represented in corresponding natural regions, is adapted with equal efficiency to its actual environment. Instances are not wanting of one type of vegetation dying out, of another slowly spreading and replacing it.

In South Africa the mediterranean vegetation of the south-western or Cape region is slowly being driven back by the drier and lower forms of the Karroos: in the savanas of Central Africa it is an open question whether the baobab or monkey-bread tree is still spreading or holding its own, indeed whether it is not gradually dying out: in the back lands of Queensland and New South Wales, there is a severe struggle between the grass-land and the thorny brigalow scrub whose formidable tangles steadily spread and kill the grass: again, the superior fitness of plants, from other but similar regions of the world, to hold the ground is well illustrated in the Plate region, where weeds imported from the Mediterranean propagate with extraordinary rapidity at the expense of the native species: or again in New Zealand, where a high proportion of foreign plants have been able successfully to compete with the indigenous vegetation. Nearer home, the advance of

the spruce forests from east to west through north-western Europe is an established fact. Gradual changes of climate are almost certainly responsible for the retreat of the Canary temperate rain-forests to secluded moist gorges; for the transformation of the vegetation of Cyprus and Cyrenaïca, the latter once a granary of Rome: again, travellers through the deserts of Takla-makan report having passed through endless miles of dead scrub of saxaul and other desert shrubs.

That the length of time during which the present physical conditions have prevailed, and therefore during which the process of adjustment has been going on, has been unequal in various corresponding regions, is highly probable and, in some instances, is established beyond doubt. The result naturally is that the aim is not attained with the same completeness everywhere and that a more or less large proportion of plant-forms belonging to previous periods in the history of these regions has been able to survive. In other words, when dealing either with single growth forms or combinations of them into landscapes, the problem involves the fourfold question:

(1) of origin, starting-point, or previous history;

(2) of process of adjustment;

(3) of time during which this process has been at work;

(4) of the gradual evolution of physical conditions; or again, of the point which the process of adjustment may have reached.

The task of finding out homologies is thus rendered somewhat complex, and the degree of correspondence is not equal in all cases.

Last, not least, man has been instrumental in introducing profound changes in the character and economy

of the world surface. The heavily forested plains of Europe and North America have retained a small proportion of woodlands: China has been cultivated for countless centuries: all over the world, whole mountain-chains have been left bereft of their plant covering and turned into arid rocks: a good deal of the treelessness of the Asiatic grass-lands is probably due to persistent depredations: the tropical savana has been extended and depleted by yearly grass fires at the expense of woodlands and even of the tall forests.

This interference with the balance of nature, sometimes justified by the very necessities of life, and constituting legitimate improvements upon the original conditions, from man's standpoint, has, in countless other instances, been the result of ignorance and improvidence, involving consequences disastrous for humanity. It is somewhat sad to reflect that the activity of quite a considerable portion of mankind is devoted to repairing damages done by other portions, or by former generations.

What has been said hitherto of the large masses of vegetation obtains, and in a still larger measure, when considering the various minor units of different orders which compose them, and may be conveniently termed here plant formations or communities. Ultimately, among the primitive units, the growth forms or vegetative types, which correspond to plant species in the study of the flora, analogies of this sort are innumerable. To mention only one or two of the most striking instances: the candelabra cerei or cacti of America correspond to the candelabra euphorbia of Africa; the agaves of Mexico and Texas are equivalent to many forms of African aloes, and are frequently mistaken for them; or again, analogous cushion-forms in arctic or in alpine regions are drawn from the most diverse orders

of plants: the 'elfin' form is assumed by shrubs of widely separated families in widely separated habitats.

Botanic gardens, with their conservatories, thus group together plants of the same requirements and modes of life, and provide them as far as possible with the most favourable conditions. Hence the variety of moist tropical hothouses, dry tropical houses, fern and palm houses, temperate houses, alpine rockeries, marshes, &c., endeavouring to copy the conditions of climate and soils suitable to analogous plant forms. It is there that the variety and uniformity of Nature will be best studied in our countries.

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The spelling of the names following is that of Chisholm's *Gazetteer of the World.*

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Gerth van Wijk, *Dictionary of Plant Names*, and Engler-Prantl, *Natürliche Pflanzenfamilien*, have been taken as authorities in compiling this Index.

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