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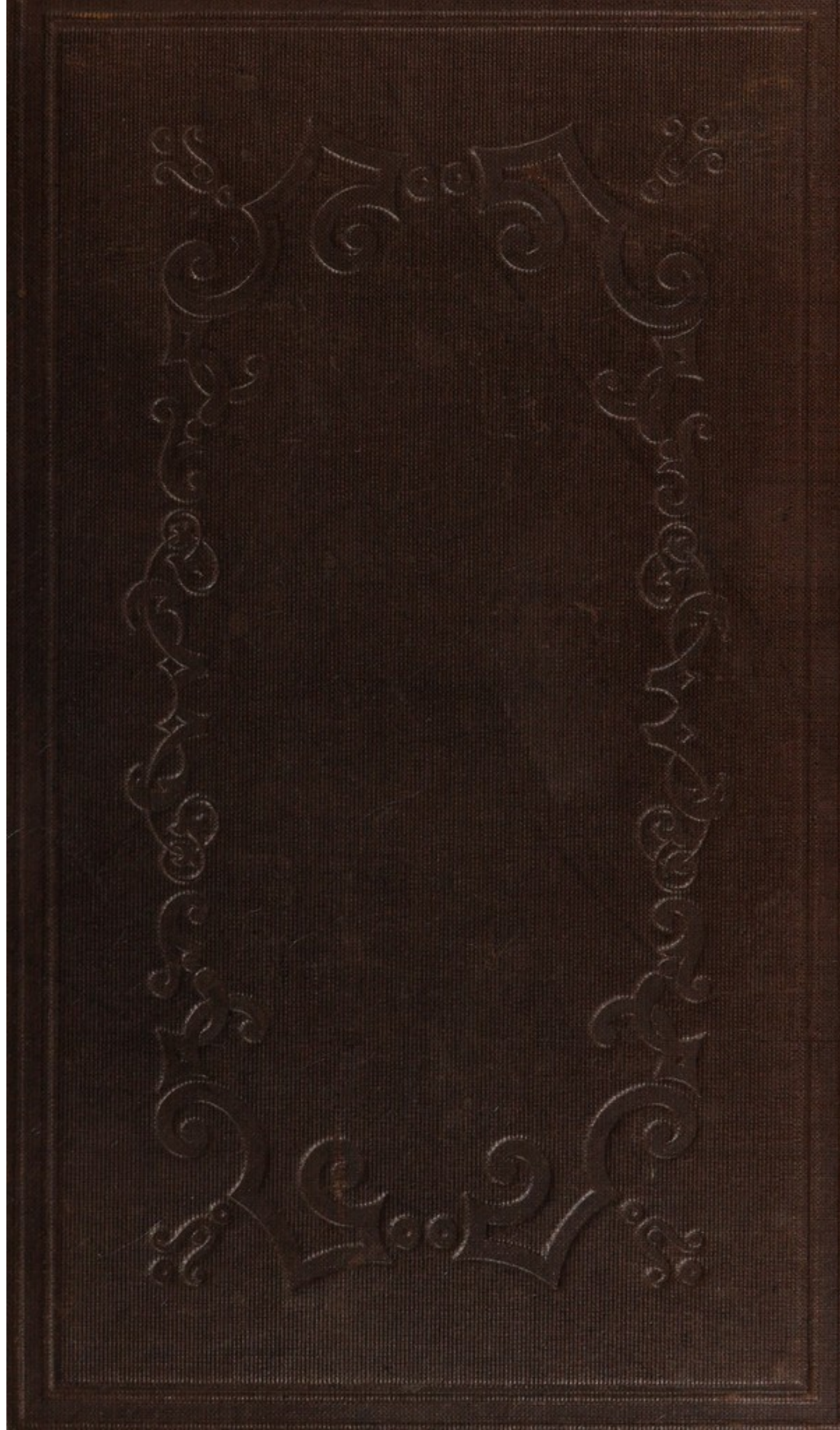
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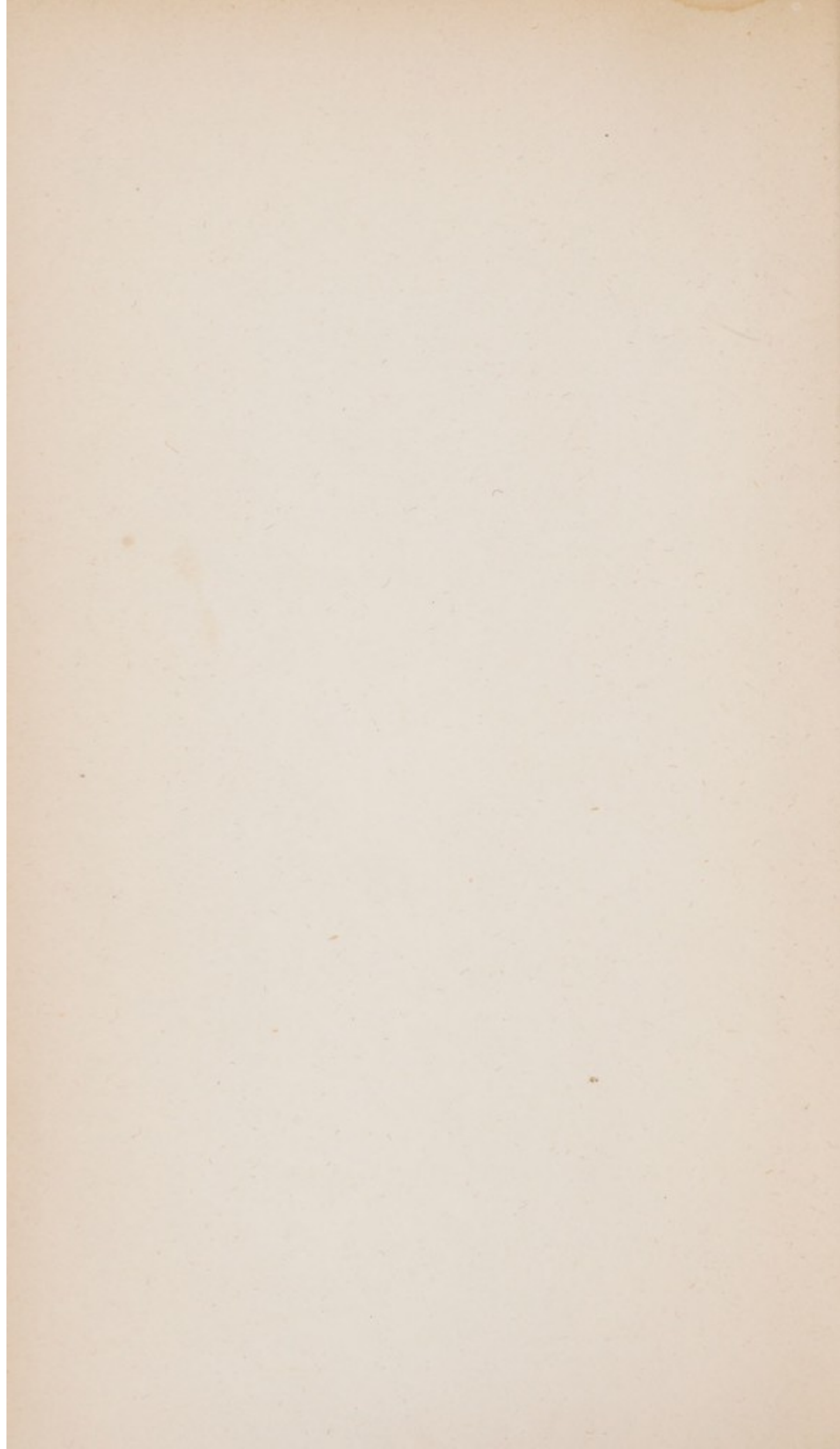




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PHYSICAL GEOGRAPHY



THE UNIVERSITY OF CHICAGO

PHYSICAL GEOGRAPHY.



PHYSICAL

GEOGRAPHY

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BY

MARY SOMERVILLE,


AUTHOR OF "THE CONNECTION OF THE PHYSICAL SCIENCES;"

"MECHANISM OF THE HEAVENS."

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PHILADELPHIA:  
LEA AND BLANCHARD.

1848.





PHYSICAL

GEOGRAPHY:

MARY SOMERVILLE

Author of "THE CONCEPTION OF THE PHYSICAL SCIENCES"

"MECHANICS OF THE HEAVENS"

PHILADELPHIA

LEE AND BLANCHARD

1848



TO

SIR JOHN F. W. HERSCHEL, BART., K.H.,

&c. &c.

DEAR SIR JOHN,

I AVAIL myself with pleasure of your permission to dedicate my book to you, as it gives me an opportunity of expressing my admiration of your talents, and my sincere estimation of your friendship.

I remain, with great regard,

Yours truly,

MARY SOMERVILLE.

*London, 29th February, 1848.*

SIR JOHN F. W. HERSCHELL, BART., & CO.

Dear Sir,

I have the pleasure of your permission to deliver the  
lectures in your name, and my sincere thanks for the  
kindness of your friends, and my sincere thanks for the  
kindness of your friends, and my sincere thanks for the

I remain, with great respect,

Yours truly,

Wm. Brewster

Great Room

London 20th February 1875

# CONTENTS.

## CHAPTER I.

Geology . . . . .	Page 13
-------------------	---------

## CHAPTER II.

Form of the Great Continent—The High Lands of the Great Continent: the Atlas, Spanish, French, and German Mountains—The Alps, Balkan, and Apennines . . . . .	33
---	----

## CHAPTER III.

The High Lands of the Great Continent ( <i>continued</i> )—The Caucasus—The Western Asiatic Table-land and its Mountains . . . . .	47
--	----

## CHAPTER IV.

The High Lands of the Great Continent ( <i>continued</i> )—The Oriental Table-land and its Mountains . . . . .	52
--	----

## CHAPTER V.

Secondary Mountain Systems of the Great Continent—That of Scandinavia—Great Britain and Ireland—The Ural Mountains—The Great Northern Plain . . . . .	64
---	----



## CHAPTER VI.

- The Southern Low Lands of the Great Continent, with their Secondary Table-lands and Mountains . . . . . 72

## CHAPTER VII.

- Africa : Table-land—Cape of Good Hope and Eastern Coast—Western Coast—Abyssinia—Senegambia—Low Lands and Deserts . . . 80

## CHAPTER VIII.

- American Continent—The Mountains of South America—The Andes—The Mountains of the Parima and Brazil . . . . . 88

## CHAPTER IX.

- The Low Lands of South America—Desert of Patagonia—The Pampas of Buenos Ayres—The Silvas of the Amazons—The Llanos of the Orinoco and Venezuela—Geological Notice . . . . . 102

## CHAPTER X.

- Central America—West Indian Islands—Geological Notice . . . 110

## CHAPTER XI.

- North America—Table-land and Mountains of Mexico—The Rocky Mountains—The Maritime Chain and Mountains of Russian America . . 116

## CHAPTER XII.

- North America (*continued*) :—The Great Central Plain or Valley of the Mississippi—The Alleghany Mountains—The Atlantic Slope—The Atlantic Plain—Geological Notice . . . . . 120

## CHAPTER XIII.

- Greenland—Spitzbergen—Iceland—Jan Mayen's Land—Antarctic Lands—Victoria Continent . . . . . 129

## CHAPTER XIV.

The Continent of Australia—Tasmania, or Van Diemen's Land—New Zealand—New Guinea—Borneo—Atolls—Encircling Reefs—Coral Reefs—Barrier Reefs—Volcanic Islands—Areas of Subsidence and Elevation in the Bed of the Pacific—Active Volcanoes . . . . . 137

## CHAPTER XV.

The Ocean—Its Size, Colour, Pressure, and Saltness—Tides, Waves, and Currents—Temperature—North and South Polar Ice—Inland Seas 157

## CHAPTER XVI.

Springs—Basins of the Ocean—Origin, Course, and Floods of Rivers—Hydraulic Systems of Europe—African rivers : The Nile, Niger, &c. 176

## CHAPTER XVII.

Asiatic Rivers—Euphrates and Tigris—River Systems south of the Himalaya—Chinese Rivers—Siberian Rivers . . . . . 191

## CHAPTER XVIII.

River Systems of North America—Rivers of Central America—Rivers of South America, and of Australia . . . . . 202

## CHAPTER XIX.

Lakes—Northern System of the Great Continent—Mountain System of the same—American Lakes . . . . . 212

## CHAPTER XX.

The Atmosphere . . . . . 220

## CHAPTER XXI.

Vegetation—The Nourishment and Growth of Plants Classes—Botanical Districts . . . . . 227



## CHAPTER XXII.

- Vegetation of the Great Continent—Of the Arctic Islands—And of the Arctic and North Temperate Regions of Europe and Asia . . . 240

## CHAPTER XXIII.

- Flora of Tropical Asia—Of the Indian Archipelago, India, and Arabia 253

## CHAPTER XXIV.

- African Flora—Flora of Australia, New Zealand, Norfolk Island, and of Polynesia . . . . . 259

## CHAPTER XXV.

- American Vegetation—Flora of North, Central, and South America—Antarctic Flora—Marine Vegetation . . . . . 270

## CHAPTER XXVI.

- Distribution of Insects . . . . . 288

## CHAPTER XXVII.

- Distribution of Fishes, and of the Marine Mammalia, Phocæ, Dolphins, and Whales . . . . . 293

## CHAPTER XXVIII.

- Distribution of Reptiles—Frogs and Toads—Snakes, Saurians, and Tortoises . . . . . 306

## CHAPTER XXIX.

- Distribution of Birds in the Arctic Regions—In Europe, Asia, Africa, America, and the Antarctic Regions . . . . . 316

## CHAPTER XXX.

Distribution of Mammalia throughout the Earth . . . 336

## CHAPTER XXXI.

The Distribution, Condition, and Future Prospects of the Human Race 356



## CHAPTER XX

THE HISTORY OF THE DISCOVERY OF THE NEW WORLD

## CHAPTER XXI

THE HISTORY OF THE DISCOVERY OF THE NEW WORLD

# PHYSICAL GEOGRAPHY.

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## CHAPTER I.

### GEOLOGY.

THE change produced in the civilized world within a few years, by the application of the powers of nature to locomotion, is so astonishing, that it leads to a consideration of the influence of man on the material world, his relation with regard to animate and inanimate beings, and the causes which have had the greatest effect on the physical, moral, and intellectual condition of the human race.

The former state of our terrestrial habitation, the successive convulsions which have ultimately led to its present geographical arrangement, and to the actual distribution of land and water, so powerfully influential on the destinies of mankind, are circumstances of primary importance.

The position of the earth with regard to the sun, its connexion with the bodies of the solar system, together with its size and form, have been noticed by the author elsewhere. It was there shown that our globe forms but an atom in the immensity of space, utterly invisible from the nearest fixed star, and scarcely a telescopic object to the remote planets of our own system. The increase of temperature with the depth below the surface of the earth, and the tremendous desolation hurled over wide regions by numerous fire-breathing mountains, show that man is removed but a few miles from immense lakes or seas of liquid fire. The very shell on which he stands is unstable under his feet, not only from those temporary convulsions that seem to shake the globe to its centre, but from a slow almost imperceptible elevation in some places, and an equally gentle subsidence in others,



as if the internal molten matter were subject to secular tides, now heaving and now ebbing, or that the subjacent rocks were in one place expanded and in another contracted by changes of temperature.

The earthquake and the torrent, the august and terrible ministers of Almighty power, have torn the solid earth and opened the seals of the most ancient records of creation, written in indelible characters on "the perpetual hills, and the everlasting mountains." There we read of the changes that have brought the rude mass to its present fair state, and of the myriads of beings that have appeared on this mortal stage, have fulfilled their destinies, and have been swept from existence to make way for new races which, in their turn, have vanished from the scene till the creation of man completed the glorious work. Who shall define the periods of those mornings and evenings when God saw that his work was good? and who shall declare the time allotted to the human race, when the generations of the most insignificant insect existed for unnumbered ages? Yet man is also to vanish in the ever-changing course of events. The earth is to be burnt up, and the elements are to melt with fervent heat—to be again reduced to chaos—possibly to be renovated and adorned for other races of beings. These stupendous changes may be but cycles in those great laws of the universe, where all is variable but the laws themselves and He who has ordained them.

The earth consists of a great variety of substances, some of which occur in amorphous masses, others are disposed in regular layers or strata, either horizontal or inclined at all angles to the horizon. By mining, man has penetrated only a very little way, but by reasoning from the dip or inclination of the strata at or near the surface, and from other circumstances, he has obtained a pretty accurate idea of the structure of our globe to the depth of about ten miles. All the substances of which we have any information are divided into four classes, distinguished by the manner in which they have been formed, namely—Plutonic and Volcanic rocks, both of igneous origin, though produced under different circumstances; Aqueous or Stratified rocks, entirely due to the action of water, as the name implies; and Metamorphic rocks, deposited also by water, according to the opinion of many eminent geologists, and consequently stratified, but



subsequently altered and crystallized by heat. The Aqueous and Volcanic rocks are formed at the surface of the earth, the Plutonic and Metamorphic at great depths, but all of them have originated simultaneously during every geological period, and are now in a state of slow and constant progress. The antagonist principles of fire and water have ever been and still are the cause of the perpetual vicissitudes to which the crust of the earth is liable.

It has been ascertained by observation that the Plutonic rocks, consisting of the granites and some of the porphyries, were formed in the deep and fiery caverns of the earth, of melted matter, which crystallized as it slowly cooled under enormous pressure, and was then heaved in unstratified masses by the elastic force of the internal heat even to the tops of the highest mountains, or forced in a semifluid state into fissures of the superincumbent strata, sometimes into the cracks of previously formed granite; for that rock, which constitutes the base of so large a portion of the earth's crust, has not been all formed at once; some portions had been solid while others were yet in a liquid state. This class of rocks is completely destitute of fossil remains.

Although granite and the volcanic rocks are both due to the action of fire, their nature and position are very different: granite, fused in the interior of the earth, has been cooled and consolidated before coming to the surface; besides, it generally consists of few ingredients, so that it has nearly the same character in all countries. But as the volcanic fire rises to the very surface of the earth, fusing whatever it meets with, volcanic rocks take various forms, not only from the different kinds of strata which are melted, but from the different conditions under which the liquid matter has been cooled, though most frequently on the surface—a circumstance that seems to have had the greatest effect on its appearance and structure. Sometimes it approaches so nearly to granite that it is difficult to perceive a distinction: at other times it becomes glass: in short, all those massive, unstratified, and occasionally columnar rocks, as basalt, greenstone, porphyry, and serpentine, are due to volcanic fires, and are devoid of fossil remains.

There seems scarcely to have been any age of the world in which volcanic eruptions have not taken place in some part of the globe. Lava has pierced through every descrip-



tion of rocks, spread over the surface of those existing at the time, filled their crevices, and flowed between their strata. Ever changing its place of action, it has burst out at the bottom of the sea as well as on dry land. Enormous quantities of scoriæ and ashes have been ejected from numberless craters, and have formed extensive deposits in the sea, in lakes, and on the land, in which are imbedded the remains of the animals and vegetables of the epoch. Some of these deposits have become hard rock, others remain in a crumbling state; and as they alternate with the aqueous strata of almost every period, they contain the fossils of all the geological epochs, chiefly fresh and salt water testaceæ.

According to a theory now generally adopted, which originated with Mr. Lyell, whose works are models of philosophical investigation, the metamorphic rocks, which consist of gneiss, micaschist, clay-slate, statuary marble, &c., were formed of the sediment of water in regular layers, differing in kind and colour, but, having been deposited near the places where plutonic rocks were generated, they have been changed by the heat transmitted from the fused matter, and in cooling under heavy pressure and at great depths they have become as highly crystallized as the granite itself, without losing their stratified form. An earthy stratum has sometimes been changed into a highly crystallized rock to the distance of a quarter of a mile from the point of contact by transmitted heat, and there are instances of dark-coloured limestone full of fossil shells, that has been changed into statuary marble from that cause. Such alterations may frequently be seen to a small extent in rocks adjacent to a stream of lava. There is not a trace of organic remains in the metamorphic rocks; their strata are sometimes horizontal, but they are usually tilted at all angles to the horizon, and form some of the highest mountains and most extensive table-lands on the face of the globe. Although there is the greatest similarity in the plutonic rocks in all parts of the world, they are by no means identical; they differ in colour, and even in ingredients, though these are few.

Aqueous rocks are all stratified, being the sedimentary deposits of water. They originate in the wear of the land by rain, streams, or the ocean. The débris carried by running water is deposited at the bottom of the seas and lakes,



where it is consolidated, and then raised up by subterraneous forces, again to undergo the same process after a lapse of time. By the washing away of the land the lower rocks are laid bare, and, as the materials are deposited in different places according to their weight, the strata are exceedingly varied, but consist chiefly of arenaceous or sandstone rocks, argillaceous or clayey rocks, and of calcareous rocks composed of sand, clay, and carbonate of lime. They constitute three great classes, which, in an ascending order, are the primary and secondary fossiliferous strata, and the Tertiary formations.

The primary fossiliferous strata, the most ancient of all the sedimentary rocks, consisting of limestone, sandstones, and shales, are entirely of marine origin, having been formed far from land at the bottom of a very deep ocean; consequently they contain the exuviae of marine animals only, and after the lapse of unnumbered ages the ripple marks of the waves are still distinctly visible on some of their strata. This series of rocks is subdivided into the Cambrian and the upper and lower Silurian systems, on account of differences in their fossil remains.

The Cambrian rocks, sometimes many thousand yards thick, are for the most part destitute of organic remains, but the Silurian rocks abound in them more and more as the strata lie higher in the series. In the lower Silurian group are the remains of shell-fish, almost all of extinct genera, and the few that have any affinity to those alive are of extinct species; Crinoidea, or stone-lilies, which had been fixed to the rocks like tulips on their stems, are coeval with the earliest inhabitants of the deep; and the trilobite, a jointed creature of the crab kind, with prominent eyes, are almost exclusively confined to the Silurian strata, but the last traces of them are found in the coal-measures above. In the upper Silurian group are abundance of marine shells of almost every order, together with Crinoidea, vast quantities of corals, and some sea-weeds: several fossil sauroid fish, of extinct genera, but high organization, have been found in the highest beds—the only vertebrated animal that has yet been discovered among the countless profusion of the lower orders of creatures that are entombed in the primary fossiliferous strata. The remains of one or more land-plants, in a very imperfect state, have been found in the Silurian



rocks of North America, which shows that there had been land with vegetation at that early period. The type of these plants, as well as the size of the shells and the quantity of the coral, indicate that a uniformly warm temperature had then prevailed over the globe. During the Silurian period an ocean covered the northern hemisphere, islands and lands of moderate size had just begun to rise, and earthquakes with volcanic eruptions from insular and submarine volcanos, were frequent towards its close.

The secondary fossiliferous strata, which comprise a great geological period, and constitute the principal part of the high land in Europe, were deposited at the bottom of an ocean, like the primary, from the débris of all the others carried down by water, and still bear innumerable tokens of their marine origin, although they have for ages formed part of the dry land. Calcareous rocks are more abundant in these strata than in the crystalline, probably because the carbonic acid was then, as it still is, driven off from the lower strata by the internal heat, and came to the surface as gas or in calcareous springs, which either rose in the sea, and furnished materials for shell-fish and coral insects to build their habitations and form coral reefs, or deposited their calcareous matter on the land in the form of rocks.

The Devonian or old red sandstone group, in many places ten thousand feet thick, consisting of strata of dark red and other sandstones, marls, coralline limestones, conglomerates, &c., is the lowest of the secondary fossiliferous strata, and forms a link between them and the Silurian rocks by an analogy in their fossil remains. It has fossils peculiarly its own, but it has also some shells and corals common to the strata both above and below it. There are various families of extinct sauroid fish in this group, some of which were gigantic, others had strong bony shields on their heads, and one genus, covered with enamelled scales, had appendages like wings. The shark approaches nearer to some of these ancient fish than any other now living.

During the long period of perfect tranquillity that prevailed after the Devonian group was deposited, a very warm, moist, and extremely equable climate, which extended all over the globe, had clothed the islands and lands in the ocean then covering the northern hemisphere with exuberant tropical forests and jungles. Subsequent inroads of fresh water or of



the sea, or rather partial sinkings of the land, had submerged these forests and jungles, which, being mixed with layers of sand and mud, had in time been consolidated into one mass, and were then either left dry by the retreat of the waters, or gently raised above their surface.

These constitute the remarkable group of the carboniferous strata, which consists of numberless layers of various substances filled with a prodigious quantity of the remains of fossil land-plants, intermixed with beds of coal, which is entirely composed of vegetable matter. In some cases the plants appear to have been carried down by floods and deposited in estuaries, but in most instances the beauty, delicacy, and sharpness of the impressions show that they had grown on the spot where the coal was formed. More than three hundred fossil plants have been collected from the shale where they abound, frequently with their seeds and fruit, so that enough remains to show the peculiar nature of this flora, whose distinguishing feature was the preponderance of ferns: among these there were tree-ferns which must have been forty or fifty feet high. There were also plants resembling the horse-tail tribe, of gigantic size; others like the tropical club mosses: an aquatic plant of an extinct family was very abundant, besides many others to which we have nothing analogous. Forest-trees of great magnitude, of the pine and fir tribes, flourished at that period. The remains of an extinct araucaria, one of the largest of the pine family, have been found in the British coal-fields; the existing species now grow in very warm countries: a few rare instances occur of grasses, palms, and liliaceous plants. The botanical districts were very extensive when the coal-plants were growing, for the species are nearly identical throughout the coal-fields of Europe and America. From the extent of the ocean, the insular structure of the land, the profusion of ferns and fir-trees, and the warm, moist, and equable climate, the northern hemisphere during the formation of the coal strata is thought to have borne a strong resemblance to the South Pacific, with its fern and fir clothed lands of New Zealand, Kerguelen islands, and others.

The animal remains of this period are in the mountain limestone, a rock occasionally nine hundred feet thick, which, in some instances, lies beneath the coal-measures, and sometimes alternates with the shale and sandstone. They consist



of crinoidea and marine testaceæ, among which the size of the chambered shells, as well as that of the corals, shows that the ocean was very warm at that time, even in the high northern latitudes.

The coal strata have been very much broken and deranged in many places by earthquakes, which frequently occurred during the secondary fossiliferous period, and from time to time raised islands and land from the deep. However, these and all other changes that have taken place on the earth have been gradual and partial, whether brought about by fire or water. The older rocks are more shattered by earthquakes than the newer, because the movement came from below; but these convulsions have never extended all over the earth at the same time—they have always been local: for example, the Silurian strata have been dislocated and tossed in Britain while a vast area in the south of Sweden and Russia still retains a horizontal position. There is no proof that any mountain-chain has ever been raised at once; on the contrary, the elevation has always been produced by a long-continued and reiterated succession of internal convulsions, with intervals of repose. In many instances the land has risen up or sunk down by an imperceptible equable motion continued for ages, while in other places the surface of the earth has remained stationary for long geological periods.

The magnesian limestone, or permian formation, comes immediately above the coal-measures, and consists of breccias or conglomerates, gypsum, sandstone, marl, &c.; but its distinguishing feature is a yellow limestone rock, containing carbonate of magnesia, which often takes a granular texture, and is then known as dolomite. The permian formation has a fossil flora and fauna peculiar to itself, mingled with those of the coal strata. Here the remnant of an earlier creation gradually tends to its final extinction, and a new one begins to appear. The flora is, in many instances, specifically the same with that in the coal strata below. Certain fish are also common to the two, which never appear again. They belong to a race universal in the early geological periods, and bear a strong resemblance to saurian reptiles. A small number of existing genera only, such as the shark and sturgeon, make some approach to the structure of these ancient inhabitants of the waters. The new creation is marked by the introduction of two species of saurian rep-



tiles: the fossil remains of one have been found in the magnesian limestone in England, and those of the other in a corresponding formation in Germany. They are the earliest members of a family which was to have dominion in the land and water for ages.

A series of red marls, rock-salt, and sandstones, which have arisen from the disintegration of metamorphic slates and porphyritic trap containing oxide of iron, and known as the trias or new red sandstone system, lies above the magnesian limestone. In England this formation is particularly rich in rock-salt, which, with layers of gypsum and marl, is sometimes six hundred feet thick; but in this country the muschelkalk is wanting, which in Germany is so remarkable for the quantity of organic remains. At this time creatures like frogs of enormous dimensions had been frequent, as they have left their footsteps on what must then have been a soft shore. Forty-seven genera of fossil remains have been found in the trias in Germany, consisting of shells, cartilaginous fish, encrinites, &c., all distinct in species, and many distinct in genera, from the organic fossils of the magnesian limestone below, and also from those entombed in the strata above.

During a long period of tranquillity the oolite or jurassic group was next deposited in a sea of variable depth, and consisted of sands, sandstones, marls, clays, and limestone. At this time there was a complete change in the aqueous deposits all over Europe. The red iron-stained arenaceous rock, the black coal, and dark strata were succeeded by light blue clays, pale yellow limestones, and, lastly, white chalk. The water that deposited the strata must have been highly charged with carbonate of lime, since few of the formations of that period are without calcareous matter, and calcareous rocks were formed to a prodigious extent throughout Europe; the Pyrenees, Alps, Apennines, and Balkan abound in them, and the Jura mountains, which have given their name to the series, are formed of them. The European ocean then teemed with animal life; whole beds consist almost entirely of marine shells and corals. Belemnites and ammonites, from an inch in diameter to the size of a cart-wheel, are entombed by myriads in the strata; whole forests of that beautiful zoophyte, the stone-lily, flourished on the surface of the oolite, then under the waters; and the encrinite, one of the same genus, is embedded in millions in the enchoreal shell marble, which



occupies such extensive tracts in Europe. Fossil fish are numerous in these strata, but different from those of the coal series, the permian formation, and trias. Not one genus of the fish of this period are now in existence. The newly-raised islands and lands were clothed with vegetation like that of the large islands of the intertropical Archipelagos of the present day, which, though less rich than during the carboniferous period, still indicates a very moist and warm climate. Ferns were less abundant, and they were associated with various genera and species of the cycadeæ, which had grown on the southern coast of England, and in other parts of northern Europe, congeners of the present cycas and zamia of the tropics. These plants had been very numerous, and the pandanæ, or screw-pine, the first tenant of the new lands in ancient and modern times, is a family found in a fossil state in the inferior oolite of England, which was but just rising from the deep at that time. The species now flourishing grows only on the coasts of such coral islands in the Pacific as have recently emerged from the waves. In the upper strata of this group, however, the confervæ and monocotyledonous plants become more rare—an indication of a change of climate.

The new lands that were scattered in the ocean of the oolitic period were drained by rivers, and inhabited by huge crocodiles and saurian reptiles of gigantic size, mostly of extinct genera. The crocodiles came nearest to modern reptiles, but the others, though bearing a remote similitude in general structure to living forms, were quite anomalous, combining in one the structure of various distinct creatures, and so monstrous that they must have been more like the visions of a troubled dream than things of real existence; yet in organization a few of them came nearer to the type of living mammalia than any existing reptiles do. Some of these saurians had lived in the water, others were amphibious, and the various species of one genus even had wings like a bat, and fed on insects. There were both herbivorous and predaceous saurians, and from their size and strength they must have been formidable enemies. Besides, the numbers deposited are so great that they must have swarmed for ages in the estuaries and shallow seas of the period, especially in the lias, a marine stratum of clay the lowest of the oolite series. They gradually declined towards the end of the se-



condary fossiliferous epoch, but as a class they lived in all subsequent eras, and still exist in tropical countries, although the species are very different from their ancient congeners. Tortoises of various kinds were contemporary with the saurians, also a family that still exists. In the stonefield slate, a stratum of the lower oolitic group, there are the remains of insects; and the bones of two small quadrupeds have been found there belonging to the marsupial tribe, such as the opossum; a very remarkable circumstance, because that family of animals at the present time is confined to New Holland, South America, and as far north as Pennsylvania at least. The great changes in animal life during this period were indications of the successive alterations that had taken place on the earth's surface.

The cretaceous strata follow the oolite in ascending order, consisting of clay, green and iron sands, blue limestone, and chalk, probably formed of the decay of coral and shells, which predominates so much in England and other parts of Europe, that it has given the name and its peculiar feature to the whole group. It is, however, by no means universal; the chalk is wanting in many parts of the world where the other strata of this series prevail, and then their connection with the group can only be ascertained by the identity of their fossil remains. With the exception of some beds of coal among the oolitic series, the Wealden clay, the lowest of the cretaceous group in England, is a fresh-water formation, and the tropical character of its flora shows that the climate was still very warm. Plants allied to the zamias and cycades of our tropical regions, many ferns and pines of the genus *araucaria*, characterized its vegetation, and the upright stems of a fossil forest at Portland show that it had been covered with trees. It was inhabited by tortoises approaching to families now living in warm countries, and saurian reptiles of five different genera swarmed in the lakes and estuaries. This clay contains fresh-water shells, fish of the carp kind, and the bones of wading birds. The Wealden clay is one of the various instances of the subsidence of land of which there were others during this period.

The cretaceous strata above our Wealden clay are full of marine exuviae. There are vast tracts of sand in northern Europe, and many very extensive tracts of chalk, but in the southern part of the continent the cretaceous rocks



assume a different character. There and elsewhere extensive limestone rocks, filled with very peculiar shells, show that when the cretaceous strata were forming, an ocean extended from the Atlantic into Asia, which covered the south of France, all southern Europe, part of Syria, the isles of the Ægean Sea, and the coasts of Thrace and the Troad. The remains of turtles have been found in the cretaceous group, quantities of coral, and abundance of shells of extinct species: some of the older kinds still existed, new ones were introduced, and some of the most minute species of microscopic shells, which constitute a large portion of the chalk, are supposed to be the same with creatures now alive, the first instance of identity of species in the ancient and modern creation. An approximation to recent times is to be observed also in the arrangement of organised nature, since at this early period, and indeed even in the silurian and oolitic epochs, the marine fauna was divided, as now, into distinct geographical provinces. The great saurians were on the decline, and many of them were found no more, but a gigantic creature intermediate between the living monitor and iguana, lived at this period.

An immense geological cycle elapsed between the termination of the secondary fossiliferous strata and the beginning of the tertiary. With the latter a new order of things commenced approaching more closely to the actual state of the globe. During the tertiary formation the same causes under new circumstances produced an infinite variety in the order and kind of the strata, accompanied by a corresponding change in animal and vegetable life. The old creation, which had nothing in common with the existing order of things, had passed away and given place to one more nearly approaching to that which now prevails. Among the myriads of beings that inhabited the earth and the ocean during the secondary fossiliferous epoch scarcely one species is to be found in the tertiary. Two planets could hardly differ more in their natural productions. This break in the law of continuity is the more remarkable, as hitherto some of the newly created animals were always introduced before the older were extinguished. The circumstances and climate suited to the one became more and more unfit for the other, which consequently perished gradually while their successors increased. It is possible that as observations become more extended this hiatus may be filled up.



The series of rocks from the granite to the end of the secondary fossiliferous strata, taken as a whole, constitute the solid crust of the globe, and in that sense are universally diffused over the earth's surface. The tertiary strata occupy the hollows formed in this crust, whether by subterraneous movements, by lakes, or denudation by water, as in the estuaries of rivers, and consequently occur in irregular tracts, often, however, of prodigious thickness and extent. Indeed they seem to have been as widely developed as any other formation, though time has been wanting to bring them into view.

The innumerable basins and hollows with which the continents and larger islands had been indented for ages after the termination of the secondary fossiliferous series, had sometimes been fresh-water lakes, and at other times were inundated by the sea; consequently the deposits which took place during these changes alternately contain the spoils of terrestrial and marine animals. The frequent intrusion of volcanic strata among the tertiary formations shows that, in Europe, the earth had been in a very disturbed state, and that these repeated vicissitudes had been occasioned by elevations and depressions of the soil, as well as by the action of water.

There are three distinct groups in these strata: the lowest tertiary or Eocene group, so called by Mr. Lyell, because, among the myriads of fossil shell-fish it contains, very few are identical with those now living; the Miocene, or middle group, has a greater number of the exuviae of existing species of shells; and the Pleiocene, or upper tertiary group, still more. Though frequently heaved up to great elevations on the flanks of the mountain-chains, as, for example, on the Alps and Apennines, by far the greater part of the tertiary strata maintain their original horizontal position in the very places where they were formed. Immense insulated deposits of this kind are to be met with all over the world; Europe abounds with them, London and Paris stand on such basins, and they cover immense tracts both in North and South America.

The monstrous reptiles had mostly disappeared, and the mammalia now took possession of the earth, of forms scarcely less anomalous than their predecessors, though approaching more nearly to those alive.



Numerous species of extinct animals that lived during the earliest or Eocene period have been found in various parts of the world, especially in the Paris basin, of the order of Pachydermata, to the greater number of which we have nothing analogous; they were mostly amphibious and herbivorous quadrupeds, which had frequented the borders of the rivers and lakes that covered the greater part of Europe at that time. This is the more extraordinary, as existing animals of that order, namely, a daman and three tapirs, are confined to the torrid zone. These creatures were widely diffused, and some of them were associated with genera still existing, though of totally different species; such as animals allied to the raccoon and dormouse, the ox, bear, deer, the fox, the dog, and others. Although these quadrupeds differ so widely from those of the present day, the same proportion existed then as now between the carnivorous and herbaceous genera. The spoils of marine mammalia of this period have also been found, sometimes at great elevations above the sea, all of extinct species, and some of these cetacea were of huge size. This marvellous change of the creative power was not confined to the earth and the ocean; the air also was now occupied by many extinct races of birds allied to the owl, buzzard, quail, curlew, &c. The climate must still have been warmer than at present from the remains of land and sea plants found in high latitudes. Even in England bones of the opossum, monkey, and boa have been discovered, all animals of warm countries, besides fossil sword and saw fish, both of genera foreign to the British seas.

During the Meiocene period new amphibious quadrupeds were associated with the old, of which the deinotherium is the most characteristic, and much the largest of the mammalia yet found, far surpassing the largest elephant in size, of a singular form, and unknown nature.

The palæotherium was also of this period, and also the mastodon, both of large dimensions. Various families, and even genera, of quadrupeds now existing were associated with these extraordinary creatures, though of extinct species, such as the elephant, rhinoceros, hippopotamus, tapir, horse, bear, wolf, hyæna, weasel, beaver, ox, buffalo, deer, &c.; and also marine mammalia, as dolphins, sea-calves, walruses, and lamantines. Indeed, in the constant increase of



animal life manifested throughout the whole of the tertiary strata, the forms approach nearer to living species as their remains lie high in the series.

In the older Pleiocene period some of the large amphibious quadrupeds, and other genera of mammalia of the earlier tertiary periods, appear no more; but there were the mastodon, and the *elephas primogenius*, or mammoth, some species of which, of prodigious size, were associated with numerous quadrupeds of existing genera, but lost species. Extinct species of almost all the quadrupeds now alive seem to have inhabited the earth at that time; their bones have been discovered in caverns; they were imbedded in the breccias and in most of the strata of that epoch—as the hippopotamus, rhinoceros, elephant, horse, bear, wolf, water-rat, hyæna, and various birds. It is remarkable that in the caverns of Australia the fossil bones all belong to extinct species of gigantic kangaroos and wombats, animals belonging to the marsupial family, which are so peculiarly the inhabitants of that country at the present day, but of diminished size. The newer Pleiocene strata show that the same analogy existed between the extinct and recent mammalia of South America, which, like their living congeners, as far as we know, belong to that continent alone; for the fossil remains, quite different from those in the old world, are of animals of the same genera with the sloths, anteaters, and armadilloes, which now inhabit that country, but of vastly superior size and different species. The *megatherium* and *equus curvidens*, or extinct horse, had so vast a range in America, that, while Mr. Lyell collected their bones in Georgia, in 30° N. latitude, Mr. Darwin brought them from the corresponding latitude in South America. The *equus curvidens* differed as much from the living horse as the quagga or zebra does, and the European fossil horse is also a distinct and lost animal.

The greater part of the land in the northern hemisphere was elevated above the deep during the tertiary period, and such lands as already existed acquired additional height; consequently the climate, which had previously been tropical, became gradually colder, for an increase of land, which raises the temperature between the tropics, has exactly the contrary effect in higher latitudes. Hence excessive cold prevailed during the latter part of the Pleiocene period, and



a great part of the European continent was covered by an ocean full of floating ice, not unlike that experienced at this day off the north-eastern coast of America.

During the latter of the Pleiocene period, however, the bed of that glacial ocean rose partially, and after many vicissitudes the European continent assumed nearly the form and climate it now has. There is every reason to believe that the glacial sea extended also over great portions of the arctic lands of Asia and America. Old forms of animal and vegetable life were destroyed by these alterations in the surface of the earth and the consequent change of temperature ; and when in the progress of the Pleiocene period the mountain-tops appeared as islands above the water, they were clothed with the flora and peopled by the animals they still retain ; and new forms were added as the land rose and became dry and fitted to receive and maintain the races of beings now alive, all of which had possession of the earth for ages prior to the historical or human period. Some of the extinct animals had long resisted the great vicissitudes of the times ; of these the mammoth, or *elephas primogenius*, whose fossil remains are found all over Europe, Asia, and America, but especially in the gelid soil of Siberia, alone outlived its associates, the last remnant of a former world. In two or three instances this animal has been discovered entire, entombed in frozen mud, with its hair and its flesh so fresh that wolves and dogs fed upon it. It has been supposed that, as the Siberian rivers flow for hundreds of miles from the southern part of the country to the Arctic Ocean, these elephants might have been drowned by floods while browsing in the milder regions, and that their bodies were carried down by the rivers and imbedded in mud, and frozen before they had time to decay. Although the congeners of this animal are now the inhabitants of the torrid zone, they may have been able to endure the cold of a Siberian winter. Baron Cuvier found that this animal differed as much from the living elephant as a horse does from an ass. The supply of food in summer was probably sufficient, since the quantity requisite for the maintenance of the larger animals is by no means in proportion to their bulk, and it may have migrated to a more genial climate in the cold months.

Shell-fish seem to have been more able to endure all the great geological changes than any of their organic asso-



ciates; they show a constant approximation to modern species during the progress of the tertiary periods. The whole of these strata contain enormous quantities of shells of extinct species; in the oldest, three and a half per cent. of the shells are identical with some now existing, while on the uppermost strata of this geological period there are not less than from ninety to ninety-five in a hundred identical with those now alive.

Of all the fossil fishes from the silurian strata to the end of the tertiary, not one is specifically the same with living forms, except the *Mallotus villosus*, or captan, of the salmon family, and perhaps a few others of the most recent of these periods. In the Eiocene strata one-third belong to extinct genera.

Under the vegetable mould in every country there is a stratum of loose sand, gravel, and mud lying upon the subjacent rocks, often of great thickness, called alluvium, which in the high latitudes of North America and Europe is mixed with enormous fragments of rock, sometimes angular and sometimes rounded and waterworn, which have been transported hundreds of miles from their origin. It is there known as the Boulder formation, or Northern Drift, because, from the identity of the boulders with the rocks of the northern mountains, they evidently have come from them, and their size becomes less as the distance increases. In Russia there are blocks of great magnitude that have been carried eight hundred and even a thousand miles south-east from their origin in the Scandinavian range. There is every reason to believe that such masses, enormous as they are, have been transported by icebergs and deposited when the northern parts of the continents were covered by the glacial sea. The same process is now in progress in the high southern latitudes.

The last manifestation of creative power, with few exceptions, differs specifically from all that went before; the recent strata contain only the exuviae of animals now living, often mixed with the bones and the works of man.

The thickness of the fossiliferous strata up to the end of the tertiary formation has been estimated at about seven or eight miles; so that the time requisite for their deposition must have been immense. Every river carries down mud, sand, or gravel to the sea; the Ganges brings more than



700,000 cubic feet of mud every hour, the Yellow River in China 2,000,000, and the Mississippi still more ; yet, notwithstanding these great deposits, the Italian hydrographer, Manfredi, has estimated that, if the sediment of all the rivers on the globe were spread equally over the bottom of the ocean, it would require 1000 years to raise its bed one foot ; so at that rate it would require 3,960,000 years to raise the bed of the ocean alone to a height nearly equal to the thickness of the fossiliferous strata, or seven miles and a half, not taking account of the waste of the coasts by the sea itself ; but if the whole globe be considered instead of the bottom of the sea only, the time would be nearly four times as great, even supposing as much alluvium to be deposited uniformly both with regard to time and place, which it never is. Besides, in various places, the strata have been more than once carried to the bottom of the ocean and again raised above its surface by subterranean fires after many ages, so that the whole period from the beginning of these primary fossiliferous strata to the present day must be great beyond calculation, and only bears comparison with the astronomical cycles, as might naturally be expected, the earth being without doubt of the same antiquity with the other bodies of the solar system. What then shall we say if the time be included which the granitic, metamorphic, and recent series occupied in forming ? These great periods of time correspond wonderfully with the gradual increase of animal life and the successive creation and extinction of numberless orders of being, and with the incredible quantity of organic remains buried in the crust of the earth in every country on the face of the globe.

Every great geological change in the nature of the strata was accompanied by the introduction of a new race of beings, and the gradual extinction of those that had previously existed, their structure and habits being no longer fitted for the new circumstances in which these changes had placed them. The change, however, never was abrupt, except at the beginning of the tertiary strata ; and it may be observed that, although the mammalia came last, there is no proof of progressive development, for animals and plants of high organization appeared among the earliest of their kind.

The geographical distribution of animated beings was much more extensive in the ancient seas and lands than in



later times. In very remote ages the same animal inhabited the most distant parts of the sea; the corallines built from the Equator to within ten or fifteen degrees of the Pole; and, previous to the formation of the carboniferous strata, there appears to have been even a greater uniformity in the vegetable than in the animal world, though New Holland had formed even then a peculiar district, supposing the coal in that country to be of the same epoch as in Europe and America; but as the strata became more varied, species were less widely diffused. Some of the saurians were inhabitants of both the Old and New World, while others lived in the latter only. In the tertiary periods the animals of Australia and America differed nearly as much from those of Europe as they do at the present day. The world was then, as now, divided into great physical regions, each inhabited by a peculiar race of animals; and even the different species of shell-fish of the same sea were confined to certain shores. Of 405 species of shell-fish which inhabited the Atlantic Ocean during the early and middle part of the tertiary period, only twelve were common to the American and European coasts. In fact, the divisions of the animal and vegetable creation into geographical districts had been in the latter periods contemporaneous with the rise of the land, each portion of which as it rose above the deep had been clothed with a vegetation and peopled with creatures suited to its position with regard to the equator, and to the existing circumstances of the globe; and the marine creatures had no doubt been divided into districts at the same periods, because the bed of the ocean had been subject to similar changes.

The quantity of fossil remains is so great that probably not a particle of matter exists on the surface of the earth that has not at some time formed part of a living creature. Since the commencement of animated existence, zoophytes have built coral reefs extending hundreds of miles, and mountains of limestone are full of their remains all over the globe. Mines of shells are worked to make lime; ranges of hills and rock, many hundred feet thick, are almost entirely composed of them, and they abound in every mountain-chain throughout the earth. The prodigious quantity of microscopic shells discovered by M. Ehrenberg is still more astonishing; shells not larger than a grain of sand form entire mountains:



a great portion of the hills of Casciano in Tuscany consist of chambered shells so minute that Signor Saldani collected 10,454 of them from one ounce of stone. Chalk is often almost entirely composed of them. Tripoli, a fine powder long in use for polishing metals, is almost entirely composed of shells; the polishing property is owing to their siliceous coats; and there are even hills of great extent consisting of this substance, the débris of an infinite variety of microscopic insects.

The facility with which many slates and clays are split is owing, in some instances, to layers of minute shells. Fossil fish are found in all parts of the world, and in all the fossiliferous strata, with the exception of some of the lowest, but each great geological period had species of fish peculiar to itself.

The remains of the great saurians are innumerable; those of extinct quadrupeds are very numerous; but there is no circumstance in the whole science of fossil geology more remarkable than the inexhaustible multitudes of fossil elephants that are found in Siberia. Their tusks have been an object of traffic in ivory for centuries, and in some places they have been in such prodigious quantities, that the ground is tainted with the smell of animal matter. Their huge skeletons are found from the borders of Europe through all northern Asia to its extremest point, and from the foot of the Altaï mountains to the shores of the Frozen Ocean, a surface equal in extent to the whole of Europe. Some islands in the Arctic Sea are composed almost entirely of their remains, mixed with the bones of various other animals of living genera, but extinct species.

Equally wonderful is the quantity of fossil plants that still remain, if it be considered that from the frail nature of many vegetable substances multitudes must have perished without leaving a trace behind. The vegetation that covered the terrestrial part of the globe previous to the formation of the carboniferous strata had far surpassed in exuberance the rankest tropical jungles. There are many coal-measures of great extent in various parts of the earth, especially in North America, where that of Pittsburg occupies an area of about fourteen thousand square miles; and that in the Illinois is not much inferior to the area of all England.

As coal is entirely a vegetable substance, some idea may



be formed of the richness of the ancient flora ; in latter times it was less exuberant, and never has again been so luxuriant, probably on account of the decrease of temperature during the deposition of the tertiary strata, and in the glacial period which immediately preceded the creation of the present tribes of plants and animals. Even after their introduction the temperature must have been very low, but by subsequent changes in the distribution of the sea and land the cold was gradually mitigated, till at last the climate of the northern hemisphere became what it is now.

Such is the marvellous history laid open to us on the earth's surface. Surely it is not the heavens only that declare the glory of God,—the earth also proclaims His Handiwork!

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## CHAPTER II.

FORM OF THE GREAT CONTINENT—THE HIGH LANDS OF THE GREAT CONTINENT:—THE ATLAS, SPANISH, FRENCH AND GERMAN MOUNTAINS—THE ALPS, BALKAN, AND APENNINES.

AT the end of the tertiary period the earth was much in the same state that it is at present with regard to the distribution of land and water. The preponderance of land in the northern hemisphere indicates a prodigious accumulation of internal energy under these latitudes at a very remote geological period. The forces that raised the two great continents above the deep, when viewed on a wide scale, must evidently have acted at right angles to one another, nearly parallel to the equator in the old continent, and in the direction of the meridian in the new ; yet the structure of the opposite coasts of the Atlantic points at some connection between the two.

The tendency of the land to assume a peninsular form is very remarkable ; and it is still more so that almost all the peninsulas tend to the south, while to the north, with a very few exceptions, the two great continents terminate in a very broken line, and, as they sink under the Icy Ocean, the tops of their high lands and mountains rise above the waves and



stud the coast with innumerable snow-clad rocks and islands. Eastern Asia is evidently continued in a subaqueous continent from the Indian Ocean across the Pacific nearly to the west coast of America, of which New Holland, the Indian Archipelago, the islands of the Asiatic coast and of Oceanica, are the great table-lands and summits of its mountain-chains.

Of the Polar lands little is known. Greenland probably is part of a continent, the domain of perpetual snow ; and the recent discovery of so extensive a mass of high volcanic land near the South Pole is an important event in the history of physical science, though the stern severity of the climate must for ever render it unfit for the abode of animated beings or even for the support of vegetable life. It seems to form a counterpoise to the preponderance of dry land in the northern hemisphere. There is something sublime in the contemplation of these lofty and unapproachable regions—the awful realm of ever-during ice and perpetual fire, whose year consists of one day and one night. The strange and terrible symmetry in the nature of the lands within the Polar circles, whose limits are to us a blank, where the antagonist principles of cold and heat meet in their utmost intensity, fills the mind with that awe which arises from the idea of the unknown and the indefinite.

The mountains, from their rude and shattered condition, bear testimony to repeated violent convulsions similar to modern earthquakes ; while the high table-lands, and that succession of terraces by which the continents sink down from their mountain-ranges to the plains, to the ocean, and even below it, show also that the land must have been heaved up occasionally by slow and gentle pressure, such as appears now to be gradually elevating the coast of Scandinavia and many other parts of the earth. The periods in which these majestic operations were effected must have been incalculable, since the dry land occupies an area of nearly thirty-eight millions of square miles.

The division of the land is very unequal : the great continent has an area of about twenty-four millions of square miles, while the extent of America is about eleven millions, and that of Australia, with its islands, scarcely three ; Africa is more than three times the size of Europe, and Asia is more than four times as large.

The peninsular form of the continents adds greatly to the



extent of their coasts, of such importance to civilization and commerce. All the shores of Europe are deeply indented and penetrated by the Atlantic Ocean, which has formed a number of inland seas of great magnitude, so that it has a greater line of maritime coast compared with its size than any other quarter of the world. The extent of coast from the Straits of Waigatz in the Polar Ocean to the Strait of Caffa at the entrance of the Sea of Azoff, is about seventeen thousand miles. The coast of Asia has been much worn by currents, and possibly also by the action of the ocean occasioned by the rotation of the earth from west to east. On the south and east especially it is indented by large seas, bays, and gulfs; and the eastern shores are rugged, and encompassed by chains of islands which render navigation dangerous. Its maritime coast is about thirty-three thousand miles in length.

The coast of Africa, sixteen thousand miles long, is very entire, except perhaps at the Gulf of Guinea and in the Mediterranean. The shores of North America have probably been much altered by the equatorial current and the gulf-stream. There cannot be a doubt that these currents, combined with volcanic action, have hollowed out the Gulf of Mexico, and separated the Antilles and Bahama Islands from the continent. The coast is less broken on the west, but in the Icy Ocean there is a labyrinth of gulfs, bays, and creeks. The shores of South America, on both sides, are very entire except towards Cape Horn and Southern Chili, where the tremendous surge and currents of the ocean in those high latitudes have eaten into the mountains, and produced endless irregularities and fiords, which run far into the land. The whole continent of America has a sea-coast of thirty-one thousand miles. Thus it appears that the ratio of the number of linear miles in the coast-line to that of square miles in the extent of surface, in each of these great portions of the globe, is 164 for Europe, 376 for Asia, 530 for Africa, and 359 for America. Hence the proportion is most favourable to Europe with regard to civilization and commerce; America comes next, then Asia, and last of all Africa, which has every natural obstacle to contend with, from the extent and nature of its coasts, the desert character of the country, and the unwholesomeness of its climate, on the Atlantic coast at least.



The continents had been raised from the deep by a powerful effort of the internal forces acting under widely-extended regions, and the stratified crust of the earth either remained level, rose in undulations, or sank into cavities, according to its intensity. Some thinner portion of the earth's surface, giving way to the internal forces, had been rent into deep fissures, and the mountain masses had been raised by violent concussions, perceptible in the convulsed state of their strata. The centres of maximum energy are marked by the pyrogenous rocks which generally form the nucleus or axis of the mountain masses, on whose flanks the stratified rocks are tilted at all angles to the horizon, whence declining on every side they sink to various depths or stretch to various distances on the plains. Enormous as the mountain-chains and tablelands are, and prodigious as the forces that elevated them, they bear a very small proportion to the mass of the level continents and to the vast power which raised them even to their inferior altitude. Both the high and the low lands had been elevated at successive periods; some of the very highest mountain-chains are but of recent geological date, and some chains that are now far inland once stood up as islands above the ocean, while marine strata filled their cavities and formed round their bases. The influence of mountain-chains on the extent and form of the continents is beyond a doubt.

Notwithstanding the various circumstances of their elevation, there is everywhere a certain regularity of form in mountain masses, however unsymmetrical they may appear at first, and rocks of the same kind have identical characters in every quarter of the globe. Plants and animals vary with climate, but a granite mountain has the same peculiarities in the southern as in the northern hemisphere, at the equator as near the poles. Single mountains, insulated on plains, are rare, except where they are volcanic; they generally appear in groups intersected by valleys in every direction, and more frequently in extensive chains symmetrically arranged in a series of parallel ridges, separated by narrow longitudinal valleys, the highest and most rugged of which occupy the centre: when the chain is broad and of the first order in point of magnitude, peak after peak arise in endless succession. The lateral ridges and valleys are constantly of less elevation, and are less bold, in proportion to their distance from the central mass, till at last the most remote ridges sink



down into gentle undulations. Extensive and lofty branches diverge from the principal chains at various angles, and stretch far into the plains. They are often as high as the chains from which they spring, and it happens not unfrequently that these branches are united by transverse ridges, so that the country is often widely covered by a network of mountains, and, at the point where these offsets diverge, there is frequently a knot of mountains spreading over hundreds of square miles. The circumstances of elevation are not the only causes of that variety observed in the summits of mountain-chains; a very minute difference in the composition and internal structure of a rock has great influence upon its general form, and on the degree and manner in which it is worn by the weather.

One side of a mountain-range is usually more precipitous than the other, but there is nothing in which the imagination misleads the judgment more than in estimating the steepness of a declivity. In the whole range of the Alps there is not a single rock which has 1600 feet of perpendicular height, or a vertical slope of  $90^{\circ}$ . The declivity of Mont Blanc towards the Allée Blanche, precipitous as it seems, does not amount to  $45^{\circ}$ ; and the mean inclination of the Peak of Teneriffe, according to Baron Humboldt, is only  $12^{\circ} 30'$ . The Silla of Caraccas, which rises precipitously from the Caribbean Sea, at an angle of  $53^{\circ} 28'$ , to the height of between six and seven thousand feet, is a majestic instance of the nearest approach to perpendicularity of any great height yet known.

Immediately connected with the mountains are the high table-lands which form so conspicuous a feature in the Asiatic and American continents. These perpetual storehouses of the waters send their streams to refresh the plains, and to afford a highway between the nations. Table-lands of less elevation, sinking in terraces of lower and lower level, constitute the links between the high ground and the low, the mountains and the plains, and thus maintain the continuity of the land. They frequently are of the richest soil, and enjoy the most genial climate, affording a delightful and picturesque abode to man, though the plains are his principal dwelling. Sloping imperceptibly from the base of the inferior table-lands, or from the last undulations of the mountains to the ocean, they carry off the superfluous waters. Fruit-



fulness and sterility vary their aspect ; immense tracts of the richest soil are favoured by climate and hardly require culture ; a greater portion is only rendered productive by hard labour, compelling man to fulfil his destiny ; while vast regions are doomed to perpetual barrenness, never gladdened by a shower.

The form of the great continent has been determined by an immense zone of mountains and table-lands, lying between the 30th and 40th or 45th parallels of north latitude, which stretches across it from W.S.W. to E.N.E., from the coasts of Barbary and Portugal on the Atlantic Ocean to the farthest extremity of Asia at Behring's Straits in the North Pacific. North of this lies an enormous plain, extending almost from the Pyrenees to the utmost part of Asia, the greatest portion of which is a dead level, or low undulations, uninterrupted, except by the Scandinavian and British system on the north, and the Ural chain, which is of small elevation. The low lands south of the mountainous zone are much indented by the ocean, and of the most diversified aspect. But much the greater part of the flat country lying between the China Sea and the river Indus is of the most exuberant fertility, while that between the Persian Gulf and the foot of the Atlas is, with some happy exceptions, one of the most desolate tracts on the earth. These southern lowlands, too, are broken by a few mountain systems of considerable extent and height.

The Atlas and Spanish mountains form the western extremity of that great zone of high lands that girds the old continent almost throughout its extent. These two mountain systems were certainly at one time united ; and, from their geological formation, and also the parallelism of their mountain-chains, they must have been elevated by forces acting in the same direction,—now, indeed, the Straits of Gibraltar, a sea-filled chasm of unfathomable depth, divides them.

A very elevated and continuous mountainous region extends in a broad belt along the north-west of Africa, from the promontory of Gher on the Atlantic to the Gulf of Sidra on the Mediterranean, inclosing all the high lands of Morocco, Algiers, and Tunis. It is bounded by the Atlantic and Mediterranean, and insulated from the rest of Africa by the Sahara desert.

This mountain system consists of three parts. The chain of the Greater Atlas, which is farthest inland, extends from



Souse near the Atlantic to the Lesser Syrte, and in Morocco forms a mountain-knot 15,000 feet high, perpetually covered with snow.

The Lesser Atlas begins at Cape Kotes opposite to Gibraltar, and keeps parallel to the Mediterranean till it attains the Gharian range in Tripoli, the last and lowest of the Little Atlas, which runs due east in a uniformly diminishing line till it vanishes in the plains of the Great Syrte. That long, rugged, but lower chain of parallel ridges and groups, which forms the bold coasts of the Straits of Gibraltar and the Mediterranean, is only a portion of the Lesser Atlas, which rises above it majestically, covered with snow. The flanks of the mountains are generally covered with forests, but their summit is one uninterrupted line of bare inaccessible rocks, and they are rent by fissures frequently not more than a few feet wide,—a peculiar feature of the whole system.

The Middle Atlas, lying between the two great chains, consists of a table-land, rich in valleys and rivers, which rises in successive terraces to the foot of the Greater Atlas, separated by ranges of hills parallel to it. This wide and extensive region has a delightful climate, abounds in magnificent forests, and the valleys are full of vitality. The crest of the Atlas is of granite and crystalline strata; their flanks and lower ranges are sandstone and limestone, on which the tertiary strata rest.

The Spanish peninsula consists chiefly of a table-land traversed by parallel ranges of mountains, and surrounded by the sea, except where it is separated from France by the Pyrenees, which extend from the Mediterranean to the Bay of Biscay, but are continued by the Cantabrian chain to Cape Finisterre on the Atlantic.

The Pyrenean chain is of moderate height at its extremities, but its summit maintains a waving line whose mean altitude is 7000 feet; it rises to a greater height on the east; its highest point is the Pic du Midi, 11,000 feet above the sea. The snow lies deep on these mountains during the greater part of the year, and is perpetual on the highest parts; but the glaciers, which are chiefly on the northern side, are neither so numerous nor so large as in the Alps.

The greatest breadth of this range is about sixty miles, and its length two hundred and seventy. It is so steep on



the French side, so rugged, and so notched, that from the plains below its summits look like the teeth of a saw, whence the term *Sierra* has been appropriated to mountains of this form. On the Spanish side, gigantic sloping offsets, separated by deep precipitous valleys, penetrate to the banks of the *Ebro*. All the Spanish mountains are torn by deep crevices, the beds of torrents and rivers.

The interior of Spain is a table-land, with an area of 93,000 square miles, nearly equal to half of the peninsula. It dips to the Atlantic from its western side, where its altitude is about 2500 feet. There it is bounded by the Iberian mountains, which begin at the point where the Pyrenees take the name of the Cantabrian chain, and run in a tortuous south-easterly direction through all Spain, constituting the western boundary of Valencia and Murcia, and sending many branches through those provinces to the Mediterranean. Its most elevated point is the *Sierra Urbian*, 7272 feet high.

Four nearly parallel ranges of mountains originate in this limiting chain, running from N.E. to S.W. diagonally across the peninsula to the Atlantic. Of these the high Castilian mountains and the *Sierra di Toledo* cross the table-land; the *Sierra Morena*, so called from the dingy colour of its forests of *Hermes oak*, on the southern edge; and, lastly, the *Sierra Nevada*, though only a hundred miles long and fifty broad, the finest range of mountains in Europe after the Alps, traverses the plains of Andalusia and Grenada. The table-land is monotonous and bare of trees; the plains of Old Castile are as naked as the steppes of Siberia, and uncultivated except along the banks of the rivers. Corn and wine are produced in abundance on the wide plains of New Castile and Estremadura; other places serve for pasture. The table-land becomes more fertile as it descends towards Portugal, which is altogether more productive than Spain, though the maritime provinces of the later on the Mediterranean are luxuriant and beautiful with a semi-tropical vegetation.

Granite, crystalline strata, and primary fossiliferous rocks prevail chiefly in the Spanish mountains, and give them their peculiar bold serrated aspect. The tracts between the parallel ranges through which the great Spanish rivers flow to the Atlantic appear to have been at one time the basins of lakes.



The mass of the high land is continued through the south of France, at a much lower elevation, by chains of hills and table-lands, the most remarkable of which are the Montagnes Noires, and the great platform of Auvergne, once the theatre of violent volcanic action. It continued from the beginning to the middle of the tertiary period, so that there are craters of various ages and perfect form: some of the highest, as the Puy de Dôme, 5000 feet high, are trachytic craters of elevation; Mont Dore, 6200 feet high, is probably the most elevated. These volcanic mountains of Auvergne, and the Cevennes, above 6000 feet high, are the most remarkable of the French system; the offsets of the latter reach the right bank of the Rhone and the Jura mountains of the Alpine range. In fact, the French mountains are the link between the more elevated masses of western and eastern Europe.

The eastern and highest part of the European portion of the mountain-zone begins to rise above the low lands about the 52d parallel of north latitude, ascending by terraces, groups, and chains of mountains, through six or seven degrees of latitude, till it reaches its highest point in the great range of the Alps and Balkan. The descent on the south side of this lofty mass is much more rapid and abrupt, and the immediate offsets from the Alps shorter; but, taking a very general view, the Apennines and mountains of northern Sicily, those of Greece and the southern part of Turkey in Europe, with all the islands of the adjacent coasts, are but outlying members of the general protuberance.

The principal chain of the Hyrcanian mountains, the Sudetes, and the Carpathian mountains, form the northern boundary of these high lands: the first, consisting of three parallel ridges, extends from the right bank of the Rhine to the centre of Germany, about  $51^{\circ}$  or  $52^{\circ}$  of N. lat., with a mean breadth of about a hundred miles, and terminates in the knot of the Fichtelberge, covering an area of 9000 square miles, on the confines of Bavaria and Bohemia. The Sudetes begin on the east of this group, and, after a circuit of three hundred miles round Bohemia, terminate at the small elevated plain of the Upper Oder, which connects them with the Carpathian mountains. No part of these limiting ranges attain the height of 5000 feet, except the Carpathians, some of which are very high. They consist of mountain groups, united by elevated plains, rather than of a single chain: the



Tatra mountains, bisected by the 20th meridian, is their loftiest point. This range is high also in Transylvania, before it reaches the Danube, which divides it from a secondary branch of the Balkan. Spurs decline in undulations from these limiting chains on the great northern plain, and the country to the south, intervening between them and the Alps, is covered with an intricate net-work of mountains and plains of moderate elevation.

The higher Alps, which form the western crest of the elevated zone, begin at the Capo della Melle, on the Gulf of Genoa, and bend round by the west and north to Mont Blanc; then turning E.N.E. they run through the Grisons and Tyrol to the Great Glockner in  $40^{\circ} 7' N.$  lat. and  $12^{\circ} 43' E.$  long., where the higher Alps terminate a course 420 miles long. All this chain is lofty; much of it is above the line of perpetual congelation, but the most elevated part lies between the Col de la Seigne, on the west shoulder of Mont Blanc, and the Simplon. The highest mountains in Europe are comprised within this space, not more than sixty miles long, where Mont Blanc, the highest of all, has an absolute elevation of 15,730 feet. The central ridge of the higher Alps is jagged with peaks, pyramids, and needles of bare and almost perpendicular rock, rising from fields of perpetual snow and rivers of ice to an elevation of 14,000 feet. Many parallel chains and groups, alike rugged and snowy, press on the principal crest, and send their flanks far into the lower grounds. Innumerable secondary branches, hardly lower than the main crest, diverge from it in various directions; of these the chain of the Bernese Alps, is the highest and most extensive. It breaks off at St. Gothard, in a line parallel to the principal chain, separates the Valais from the canton of Bern, and with its ramifications forms one of the most remarkable groups of mountain scenery in Europe. Its endless maze of sharp ridges and bare peaks, mixed with gigantic masses of pure snow fading coldly serene into the blue horizon, present a scene of sublime quiet and repose, unbroken but by the avalanche or the thunder.

At the Great Glockner, the range of the Alps, hitherto undivided, splits into two branches, the Noric and Carnic Alps: the latter is the continuation of the chief stem. Never rising to the height of perpetual snow, it separates the Tyrol and Upper Carinthia from the Venetian States, and, taking



the name of the Julian Alps at Mont Terglou, 9380 feet above the sea, runs east till it joins the eastern Alps or Balkan, under the 18th meridian. Offsets from this chain cover all the neighbouring countries.

It is difficult to estimate the width of the Alpine chain ; that of the higher Alps is about a hundred miles ; it increases to a hundred and fifty east of the Grisons, and amounts to two hundred between the 15th and 16th meridians, but is not more than eighty at its junction with the Balkan.

The Stelvio, 9174 feet above the sea, is the highest carriage-pass in these mountains. That of St. Gothard is the only one which goes directly over the crest of the Alps. Passes very rarely go over the summit of a mountain ; they generally cross the water-shed, ascending by the valley of a torrent, and descending by a similar path on the other side.

The frequent occurrence of extensive deep lakes is a peculiar feature in European mountains, rarely to be met with in the Asiatic system, except in the Altaï, and on the elevated plains.

With the exception of the Jura, whose pastoral summit is about 3000 feet above the sea, there are no elevated table-lands in the Alps ; the tabular form, so eminently characteristic of the Asiatic high lands, begins in the Balkan. The Oriental peninsula rises by degrees from the Danube to Bosnia and Upper Macedonia, which are some hundred feet above the sea ; and the Balkan extends six hundred miles along this elevated mass, from the Julian Alps to Cape Eminek on the Black Sea. It begins by a table-land seventy miles long, traversed by low hills, ending towards Albania and Myritida in a limestone wall from six to seven thousand feet high. Rugged mountains, all but impassable, succeed to this, in which the domes and needles of the Schandach, or ancient Scamus, are covered with perpetual snow. Another table-land follows, whose marshy surface is bounded by mural precipices ending at Mount Arbelus, 9000 feet high, near the town of Sophia. There the Hemus, or Balkan properly so called, begins, and runs in parallel ridges, separated by fertile longitudinal valleys, to the Black Sea, dividing the plains between the Lower Danube and the Propontis into nearly equal parts. The central ridge rises at once in a wall 4000 feet high, passable in few places ; and



where there is no lateral ridge the precipices descend at once to the plains.

The Balkan is everywhere rent by terrific fissures across the chains and table-lands, so deep and narrow that daylight is almost excluded. These chasms afford the safest passes across the range; the others, along the faces of the precipices, are frightful.

The Mediterranean is the southern boundary of the elevated zone of Eastern Europe, whose last offsets rise in rocky islands along the coasts. The crystalline mountains of Sardinia and Corsica are outlying members of the Maritime Alps, while shorter offsets end in the plains of Lombardy, forming the magnificent scenery of the Italian lakes. Even the Apennines, whose elevation has given its form to the peninsula of Italy, is but a secondary, on a greater scale, to the broad central band, as well as the mountains and high land in the north of Sicily, which form the continuation of the Calabrian chain.

The Apennines, beginning at the Maritime Alps, inclose the Gulf of Genoa, and run through the centre of Italy in parallel ranges to the middle of Calabria, where they split into two branches, one of which goes to Capo de Leuca on the Gulf of Torento, the other to Cape Spartivento in the Straits of Messina. The whole length is about eight hundred miles. None of the Apennines come within the line of perpetual snow, though it lies nine months in the year on the Gran Sasso d'Italia, 9521 feet high in Abruzzza Ulteriore.

Offsets from the Julian and Eastern Alps render Dalmatia and Albania perhaps the most rugged tract in Europe; and the Pindus, which forms the water-shed of Greece, diverges from the latter chain, and, running south two hundred miles, separates Albania from Macedonia and Thessaly.

Greece is a country of mountains, and, although none are perpetually covered with snow, it lies nine months on several of their summits. The chains terminate in strongly projecting headlands, which reach far into the sea, and reappear in the numerous islands and rocks which stud that deeply indented coast. The Grecian mountains, like the Balkan, are torn by transverse fractures. The celebrated Pass of Thermopylæ, the defile of Blatamana, and the Gulf of Salonica are examples. The Adriatic, the Dardanelles, and the Sea of Marmora limit the secondaries of the southern part of the Balkan.



The valleys in the Alps are long and narrow ; those among the mountains of Turkey in Europe and Greece are mostly caldron-shaped hollows, often inclosed by mural rocks. Many of these cavities of great size lie along the foot of the Balkan. In the Morea they are so encompassed by mountains that the water has no escape but through the porous soil. They consist of tertiary strata, which had formed the bottom of lakes. Caldron-shaped valleys occur in most volcanic countries, as Sicily, Italy, and central France.

The table-lands which constitute the tops of mountains or of mountain-chains are of a different character from those terraces by which the high lands slope to the low. The former are on a small scale in Europe, and of a forbidding aspect, with the exception of the Jura, which is pastoral ; whereas the latter are almost always habitable and cultivated. The mass of high land in South-Eastern Europe shelves on the north to the great plain of Bavaria, 3000 feet high ; Bohemia, which slopes from 1500 to 900, and Hungary, from 4000 above the sea to 300. The descent on the south of the Alps is six or seven times more rapid, because the distance from the axis of the chain is shorter.

It is scarcely possible to estimate the quantity of ice in the Alps ; it is said, however, that, independent of the glaciers in the Grisons, there are 1500 square miles of ice in the Alpine range, from eighty to six hundred feet thick. Some glaciers have been permanent and stationary in the Alps time immemorial, while others now occupy ground formerly bearing corn or covered with trees, which the irresistible force of the ice has swept away. These ice rivers, formed on the snow-clad summits of the mountains, fill the hollows and high valleys, hang on the declivities, or descend by their weight through the transverse valleys to the plains, where they are cut short by the increased temperature, and deposit those accumulations of rocks and rubbish, called moraines, which had fallen upon them from the heights above. In the Alps the glaciers move at the rate of from twelve to twenty feet annually, and, as in rivers, the motion is most rapid in the centre. They advance or retreat according to the mildness or severity of the season, but they have been subject to cycles of unknown duration. From the moraines, as well as the striæ engraven on the rocks over which they have passed, M. Agassiz has ascertained that the



valley of Chamouni was at one time occupied by a glacier that had moved towards the Col di Balme. A moraine 2000 feet above the Rhone at St. Maurice shows that at a remote period glaciers had covered Switzerland to the height of 2155 feet above the Lake of Geneva.

Their increase is now limited by various circumstances—as the mean temperature of the earth, which is always above the freezing-point in those latitudes; excessive evaporation; and blasts of hot air, which occur at all heights, in the night as well as in the day, from some unknown cause. They are not peculiar to the Alps, but have been observed also on the glaciers of the Andes. Besides, the greater the quantity of snow in the higher Alps, the lower is the glacier forced into the plains.

Granite no doubt forms the base of the mountain system of Eastern Europe, though it more rarely comes into view than might have been expected. Crystalline schists of various kinds are enormously developed, and generally form the most elevated pinnacles of the Alpine crest and its offsets; but the secondary fossiliferous strata constitute the chief mass, and often rise to the highest summits; indeed, secondary limestones occupy a great portion of the high land of Eastern Europe. Calcareous rocks form two great mountain-zones on each side of the central chain of the Alps, and rise occasionally to altitudes of ten or twelve thousand feet. They constitute the central range of the Apennines, and fill the greater part of Sicily. They are extensively developed in Turkey in Europe, where the plateau of Bosnia with its high lands on the south, part of Macedonia, and Albania with its islands, are principally composed of them. Tertiary strata, of great thickness, rest on the flanks of the Alps, and rise in some places to a height of five thousand feet. Zones of the older Pleiocene period flank the Apennines on each side, filled with organic remains; and half of Sicily is covered with the newer Pleiocene strata.

From numerous dislocations in the strata, the Alps appear to have been heaved up by many violent and repeated convulsions, separated by intervals of repose, and different parts of the chain have been raised at different times; for example, the Maritime Alps and the south-western part of the Jura Mountains were raised previous to the formation of



the chalk : but the tertiary period appears to have been that of the greatest commotions ; for nearly two-thirds of the lands of Europe have risen since the beginning of that epoch, and those that existed then acquired additional height, though some sank below their original level. During that time the Alps acquired an additional elevation of between two and three thousand feet ; Mont Blanc then reached its present altitude ; the Apennines rose one or two thousand feet higher ; and the Carpathians seem to have gained an accession of height about the same period. That part of the Alpine chain lying between Mont Blanc and Vienna is said to have acquired its last accession of height since the seas were inhabited by the existing species of animals.

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### CHAPTER III.

THE HIGH LANDS OF THE GREAT CONTINENT (*continued*)—THE CAUCASUS—THE WESTERN ASIATIC TABLE-LAND AND ITS MOUNTAINS.

THE Dardanelles and the Sea of Marmora form but a small break in the mighty girdle of the old continent, which again appears in immense table-lands passing through the centre of Asia, of such magnitude that they occupy nearly two-fifths of the continent. Here every thing is on a much grander scale than in Europe ; the table-lands rise above the mean height of the European mountains, and the mountains themselves that gird and traverse them surpass those of every other country in altitude. The most barren deserts are here to be met with, as well as the most luxuriant productions of animal and vegetable life. The earliest records of the human race are found in this cradle of civilization, and monuments still remain which show the skill and power of those nations which have passed away, but whose moral influence is still visible in their descendants. Customs, manners, and even prejudices, carry us back to times beyond the record of history, or even of tradition ; while the magnitude with which the natural world is here developed evinces the tremendous forces that must have been in action at epochs immeasurably anterior to the existence of man.



The gigantic mass of high land which extends for 6000 miles between the Mediterranean and the Pacific is 2000 miles broad at its eastern extremity, 700 to 1000 in the middle, and somewhat less at its western termination. Colossal mountains and elevated terraces form the edges of these lofty plains.

Between the 47th and 68th eastern meridians, where the low plains of Hindostan and Bucharica press upon the table-land and reduce its width to 700 or 1000 miles, it is divided into two parts by an enormous knot of mountains formed by the meeting of the Hindoo Coosh, the Himalaya, the Thsungling, and the transverse ranges of the Beloot Tagh, or Cloudy Mountains: these two parts differ in height, form, and magnitude.

The western portion, which is the table-land of Persia or plateau of Iran, is oblong, extending from the shores of Asia Minor to the Hindoo Coosh and the Solimaun range, which skirts the right bank of the Indus. It occupies an area of 1,700,000 square miles, generally about 4000 feet above the sea, and in some places 7000. The oriental plateau or table-land of Tibet, much the largest, has an area of 7,600,000 square miles, and a mean altitude of 14,000 feet, and in some parts of Tibet an absolute altitude of 17,000 feet.

As the table-lands extend from S.W. to N.E., so also do the principal mountain-chains, as well those which bound the high lands as those which traverse them, with the exception of the Beloot Tagh, or Bolor, and the Solimaun chains, which run from north to south. The first is the western limit of the oriental plateau, the other the boundary of the table-land of Persia.

The lofty range of the Caucasus, which extends 700 miles between the Black and Caspian Seas, is an outlying member of the Asiatic high lands. Offsets diverge like ribs from each side of the central crest, which penetrate the Russian steppes on one hand, and on the other cross the plains of Kara, or valley of the Kour and Rioni, and unite the Caucasus to the table-land. Some parts of these mountains are more than 15,000 feet high; the Elbrouz, on the western border of Georgia, is 17,796 feet. The central part of the chain is full of glaciers, and the limit of perpetual snow is at the altitude of 11,000 feet, which is higher than in any other chain, except the Himalaya.



Anatolia, the most western part of the table-land of Iran, 3000 feet above the sea, is traversed by short chains and broken groups of mountains, separated by fertile valleys which sink rapidly towards the archipelago and end in promontories and islands along the shores of Asia Minor, which is a country abounding in vast luxuriant but solitary plains, watered by broad rivers. Single mountains of volcanic formation are conspicuous objects on the table-land of Anatolia, which is rich in pasture, though much of the soil is saline and covered with lakes and marshes. A triple range of limestone mountains, 6000 or 7000 feet high, divided by narrow but beautiful valleys, is the limit of the Anatolian table-land along the shores of the Black Sea. They are covered with forests to the height of 4500 feet, and broken by wooden glens, having a narrow coast, except near Trebizond, where it is broad and picturesque. The high land is bounded on the south by the serrated snowy range of the Taurus, which, beginning in Rhodes, Cos, and other islands in the Mediterranean, fills the south-western parts of Asia Minor with ramifications, and, after following the sinuosities of the iron-bound coast of Karamania in a single lofty range, extends at Samisat, where the Euphrates has pierced a way through this stony girdle.

About the 50th meridian the table-land is compressed to nearly half its width, and there the lofty mountainous regions of Armenia, Kourdistan, and Azerbaijan tower higher and higher between the Black Sea, the Caspian, and the Gulf of Alexandretta in the Mediterranean. Here the cold treeless plains of Armenia, the earliest abode of man, 7000 feet above the sea, bear no traces of the garden of Eden; but Mount Ararat, on which the ark is said to have rested, stands a solitary majestic volcanic cone 17,260 feet above the sea, shrouded in perpetual snow. Though high and cold, the soil of Armenia is better than that of Anatolia, and is better cultivated. It shelves on the north in luxuriant and beautiful declivities to the low and undulating valley of Kara, south of the Caucasus; and on the other hand, the broad and lofty belt of the Kourdistan Mountains, rising abruptly in many parallel ranges from the plains of Mesopotamia, form its southern limit, and spread their ramifications wide over its surface. They are rent by deep ravines, and in many places are so rugged that communication between the villages is



always difficult, and in winter impracticable from the depth of snow. The line of perpetual congelation is decided and even along their summit; their flanks are wooded, and the valleys populous and fertile.

A thousand square miles of Kourdistan is occupied by the brackish lake Van, which is seldom frozen, though 5467 feet above the sea and surrounded by lofty mountains.

The Persian mountains, of which the Elbrouz is the principal chain, extend along the northern brink of the plateau, from Armenia, almost parallel to the shores of the Caspian Sea, maintaining a considerable elevation up to the volcanic mountain Demavend, near Tehran, their culminating point, 14,600 feet high, which, though 90 miles inland, is a landmark to sailors on the Caspian. Elevated offsets of these mountains cover the volcanic table-land of Azerbaijan, the fire country of Zoroaster, and one of the best provinces in Persia; there the Koh Savalan elevates its volcanic cone 12,000 feet. Beautiful plains, pure streams, and peaceful glades, interspersed with villages, lie among the mountains, and the Vale of Khosran Shah, a picture of sylvan beauty, is celebrated as one of the five paradises of Persian poetry. The vegetation at the foot of these mountains on the shores of the Caspian has all the exuberance of a tropical jungle. The Elbrouz loses its height to the east of Demavend, and then joins the mountains of Khorasan and the Parapamisan range, which appear to be chains of mountains when viewed from the low plains of Khorasan and Balkh, but on the table-land of Persia they merely form a broad hilly country of rich soil till they join the Hindoo Coosh.

The table-land of Iran is bounded, for a thousand miles along the Persian Gulf and Indian Ocean, by a mountainous belt of from three to seven parallel ranges, having an average width of 200 miles, and extending from the extremity of the Kourdistan Mountains to the mouth of the Indus. The Lasistan Mountains, which form the northern part of this belt, and bound the vast level plain of the Tigris, rise from it in a succession of high table-lands divided by very rugged mountains, the last ridge of which, mostly covered with snow, abuts on the table-land of Persia. Oaks clothe their flanks; the valleys are of generous soil, verdant and cultivated; and many rivers flow through them to swell the stream of the Tigris. Insulated hill forts, from 2000 to



5000 feet high, occur in this country, with flat cultivated tops some miles in extent, accessible only by ladders or holes cut in their precipitous sides. These countries are full of ancient inscriptions and remains of antiquity. The moisture decreases more and more south from Shiraz, and then the parallel ridges, repulsive in aspect and difficult to pass, are separated by arid longitudinal valleys, which ascend like steps from the narrow shores of the Persian Gulf to the table-land. The coasts of the gulf are burning-hot sandy solitudes, so completely barren that the country from Bassora to the Indus, a distance of 1200 miles, is a sterile waste. In the few favoured spots on the terraces where water occurs there is vegetation, and the beauty of these valleys is enhanced by surrounding sterility.

With the exception of Mazenderan, and the other provinces on the Caspian and in the Parapamisan range, Persia is arid, possessing few perennial springs, and not one great river; in fact, three-tenths of the country is desert, and the table-land is nearly a wide scene of desolation. A great salt desert occupies 27,000 square miles between Irak and Khorasan, of which the soil is stiff clay covered with efflorescence of common salt and nitre, often an inch thick, varied only by a few saline plants and patches of verdure in the hollows. This dreary waste joins the large sandy and equally dreary desert of Kerman. Kelat, the capital of Belochistan, is 7000 feet above the level of the sea, round which there is cultivation, but the greater part of that country is a lifeless plain, over which the brick-red sand is drifted by the north wind into ridges like the waves of the sea, often twelve feet high, without a vestige of vegetation. The blast of the desert, whose hot and pestilential breath is fatal to man and animals, renders these dismal sands impassable at certain seasons.

Barren lands or bleak downs prevail at the foot of the Lukee and Solimaun ranges of bare porphyry and sandstone, which skirt the eastern edge of the table-land and dip to the plains of Indus. In Afghanistan there is cultivation chiefly on the banks of the streams that flow into Lake Zorah, but vitality returns towards the north-east. The plains and valleys among the offsets from the Hindoo Coosh are of surpassing loveliness, and combine the richest peaceful beauty with the majesty of the snow-capped mountains.



## CHAPTER IV.

THE HIGH LANDS OF THE GREAT CONTINENT (*continued*)—  
THE ORIENTAL TABLE-LAND AND ITS MOUNTAINS.

THE oriental plateau, or table-land of Tibet, is an irregular four-sided mass stretching from S.W. to N.E., inclosed and traversed by the highest mountains in the world. It is separated from the table-land of Persia by the Hindoo Coosh, a branch of the Himalaya, which occupies the terrestrial isthmus between the low lands of Hindostan and Bucharía.

The cold dreary plateau of Tibet is separated on the south from the glowing luxuriant plains of Hindostan by the Himalaya, which extends 2800 miles from the western extremity of the Hindoo Coosh in Cabulistan to the Gulf of Tonkin in China. The chain of the Altaï, to the north, 4500 miles long, divides the table-land from the deserts of Asiatic Siberia, and, stretching to the sea at Okhotzk under various names, it bends to the N.N.E., and terminates at Behring's Straits, the utmost extremity of Asia. The table-land terminates in the east, partly in the long Chinese chain of the Khing-Khan and Inshan Mountains, which stretch from the Altaï range to the great bend in the Yellow River in China, and farther south by the nameless and almost unknown magnificent mountains in the western provinces of the Chinese empire. On the west the table-land has its limits in the Beloot Tagh, or Cloudy Mountains, the Tartash Tagh of the natives, a transverse range, which leaves the Hindoo Coosh nearly at a right angle about the 72d degree of E. longitude, and, pursuing a northerly direction, is supposed to unite the latter chain to that of the Altaï; its offsets, at least, extend widely in that direction. It forms magnificent mountain-knots with the diagonal chains of the table-land, and is the water-shed between Independent and Chinese Tourkistan, or Tartary. It descends in a succession of tiers or terraces through the countries of Bokhara and Balkh to the deep cavity in which the Caspian Sea and the Sea of Azoff lie, and forms, with the Paralasa, the Solimaun



range, and the Ural, a singular exception to the general parallelism of Asiatic mountains. Two narrow difficult passes lead over the Beloot Tagh from the low plains of Bucharía and Independent Tourkistan to Kashgar and Yarkand, on the table-land in Chinese Tartary.

The table-land itself is crossed diagonally from west to east by two great chains of mountains. The Kuen-leun, or Chinese range, begins about  $35^{\circ} 30'$  N. lat. at the mountain-knot formed by the Hindoo Coosh and Himalaya, and, running eastward, it terminates south of the Gulf of Petcheli, and covers a great part of the western provinces of China with its branches. The Thian-shan, or Celestial Mountains, lie more to the north; they begin at the Beloot Tagh, and, running along the 42d parallel, sink to the desert of the Great Gobi, about the centre of the plateau, but, rising again, they end in various branches in China. The latter chain is exceedingly volcanic, and, though so far inland, pours forth lava, and exhibits all the other phenomena of volcanic districts.

Tibet is inclosed between the Himalaya and the Kuen-leun; Tungut, or Chinese Tartary, lies between the latter chain and the Celestial Mountains, and Zungary, or Mongolia, between the Celestial range and the Altaï. The Himalaya and Altaï ranges diverge in their easterly courses so that the table-land, which is only from 700 to 1000 miles wide at its western extremity, is 2000 between the Chinese province of Yunnan and the country of the Mantshu Tonguses.

Of all these vast chains of mountains the Himalaya and its principal branch the Hindoo Coosh, are best known; though even of these a great part has never been explored, on account of their enormous height and the depth of snow, which make it impossible to approach the central ridge, except in a very few places.

The range consists of three parts: the Hindoo Coosh, or Indian Caucasus, which extends from the Parapamisan range in Afghanistan to Cashmere; the Himalaya, or Imaus of the ancients, which stretches from the valley of Cashmere to the sources of the Brahmapootra; and, lastly, the mountains of Bhotan and Assam,—the three making one magnificent unbroken chain.

The Hindoo Coosh, which has its name from a mountain



of great height north of the city of Cabul, is very broad to the west, extending over many degrees of latitude, and together with the offsets of the Beloot Tagh, fills the countries of Kafferistan, Koondez, and Budaksha. From the plains to the south it seems to consist of four distinct ranges running one above another, the last of which abuts on the table-land, and is so high that its snowy summits are visible at the distance of 150 miles. One of the ridges runs along the table-land parallel to the principal chain at the distance of 200 miles, known as the Ice Mountains, or Kara-Korum of the natives. Another ridge of stupendous height incloses the beautiful valley of Cashmere, to the east of which the chain takes the name of Himalaya, "the dwelling of snow," and extends 300 miles to the sources of the Brahmapootra, varying in breadth from 250 to 350 miles, and occupying an area of 600,000 square miles.

The general structure of the Himalaya is very regular; the first range of hills that rise above the plains of Hindostan is alluvial, north of which lies the Tariyani, a tract from 10 to 30 miles wide, 1000 feet above the sea, covered with dense, pestilential jungle, and extending along the foot of the range. North of this region are rocky ridges, 5000 or 6000 feet high. Between these and the higher ranges lie the peaceful and well-cultivated valleys of Nepaul, Bhotan, and Assam, of inexhaustible fertility, interspersed with picturesque and populous towns and villages. Though separated by mountain-groups, they form the principal terrace of the Himalaya, between the Sutlej and the Brahmapootra. Behind these are mountains from 10,000 to 12,000 feet high, flanked by magnificent forests, and, lastly, the snowy ranges rise in succession to the table-land.

The principal and most elevated chains are cut by narrow, gloomy ravines and transverse dusky gorges, through which the torrents of melted snow rush to swell the rivers of Hindostan. The character of the valleys becomes softer in the lower regions, till at last the luxuriance of vegetation and beauty cannot be surpassed. Transverse valleys, however, are more frequent in the Hindoo Coosh than in the Himalaya, where they consist chiefly of such chasms filled with wreck as the tributaries of the Indus and Ganges have made in bursting through the chain.

The mean height of the Himalaya is stupendous, certainly



not less than from 16,000 to 20,000 feet, though the peaks exceeding that elevation are not to be numbered, especially at the sources of the Sutlej ; indeed, from that river to the Kalee the chain exhibits an endless succession of the loftiest mountains on earth : forty of them surpass the height of Chimborazo, the highest but one of the Andes, and many reach the height of 25,000 feet at least. So rugged is this part of the magnificent chain, that the military parade at Sabathoo, half a mile long, and a quarter of a mile broad, is said to be the only level ground between it and the Tartar frontier on the north, or the valley of Nepaul to the east. Towards the fruitful valleys of Nepaul and Bhotan the Himalaya is equally lofty, some of the mountains being from 25,000 to 28,000 feet high, but it is narrower, and the descent to the plains excessively rapid, especially in the territory of Bhotan, where the dip from the table-land is more than 10,000 feet in ten miles. The valleys are crevices so deep and narrow, and the mountains that hang over them in menacing cliffs are so lofty, that these abysses are shrouded in perpetual gloom, except when the rays of a vertical sun penetrate their depths. From the steepness of the descent the rivers shoot down with the swiftness of an arrow, filling the caverns with foam and the air with mist. At the very base of this wild region lies the elevated and peaceful valley of Bhotan, vividly green and shaded by magnificent forests. Another rapid descent of 1000 feet leads to the plain of the Ganges.

The Himalaya still maintains great height along the north of Assam, and at the sources of the Brahmapootra the parent stem and its branches extend in breadth over two degrees of latitude, forming a vast mountain knot, with summits 20,000 high. Beyond this point nothing certain is known of the range, but it, or some of its branches, are supposed to cross the southern provinces of the Chinese empire, and to end in the volcanic island of Formosa. Little more is known of the northern side of the mountains than that the passes are about 5000 feet above the plains of Tibet.

The passes over the Hindoo Coosh, though not the highest, are very formidable ; there are six from Cabul to the plains of Turkistan, and so deep and so much inclosed are the defiles, that Sir Alexander Burnes never could obtain an observation of the pole star in the whole journey from Barmeean till within 30 miles of Turkistan.



Most of the passes over the Himalaya are but little lower than the top of Mont Blanc ; many are higher, especially near the Sutlej, where they are from 18,000 to 19,000 feet high, and that north-east of Khoonawur is 20,000 feet above the level of the sea, the highest that has been attempted. All are terrific, and the fatigue and suffering from the rarity of the air in the last 500 feet is not to be described. Animals are as much distressed as human beings, and many die. Thousands of birds perish from the violence of the wind, the drifting snow is often fatal to travellers, and violent thunder-storms add to the horror of the journey. The Niti Pass, by which Mr. Moorcroft ascended to the sacred lake of Manasa in Tibet, is tremendous ; he and his guide had not only to walk barefooted from the risk of slipping, but they were obliged to creep along the most frightful chasms, holding by twigs and tufts of grass, and sometimes they crossed deep and awful crevices on a branch of a tree, or loose stones thrown across ; yet these are the thoroughfares for commerce in the Himalaya, never repaired nor susceptible of improvement from the frequent landslips and torrents.

The loftiest peaks being bare of snow gives great variety of colour and beauty to the scenery, which in these passes is at all times magnificent. During the day the stupendous size of the mountains, their interminable extent, the variety and sharpness of their forms, and, above all, the tender clearness of their distant outline melting into the pale blue sky, contrasted with the deep azure above, is described as a scene of wild and wonderful beauty. At midnight, when myriads of stars sparkle in the black sky, and the pure blue of the mountains looks deeper still below the pale white gleam of the earth and snow-light, the effect is of unparalleled solemnity, and no language can describe the splendour of the sunbeams at daybreak streaming between the high peaks, and throwing their gigantic shadows on the mountains below. There, far above the habitation of man, no living thing exists ; no sound is heard ; the very echo of the traveller's footsteps startles him in the awful solitude and silence that reigns in these august dwellings of everlasting snow.

Nature has in mercy mitigated the intense rigor of the cold in these high lands in a degree unexampled in other



mountainous regions. The climate is mild, the valleys are verdant and inhabited, corn and fruit ripen at elevations which in other countries, even under the equator, would be buried in permanent snow.

It is also a peculiarity in these mountains, that the higher the range the higher likewise is the limit of snow and vegetation. On the southern slopes of the first range Mr. Gerard found cultivation 10,000 feet above the sea; in the valleys of the second range he met with shepherds feeding their flocks and dwelling at the height of 14,000 feet; and on the table-land of Tibet, the highest habitation of man in the Old World, the ground is cultivated at the altitude of 13,600 feet, which is only 2130 feet lower than the summit of Mont Blanc. In Chinese Tartary good crops of wheat are raised 16,000 feet above the sea; the vine and other fruit thrive in the valleys of these high plains. The temperature of the earth probably has some influence on the vegetation; as many hot springs exist in the Himalaya at great heights, there must be a source of heat below these mountains which in some places comes near the surface, and possibly may be connected with the volcanic fires in the central chains of the table-land. Hot springs abound in the valley of Jumnotra; and as it is well known that many plants thrive in very cold air if their roots are well protected, it may be the cause of pine-trees flourishing in that valley nearly 13,000 feet above the sea, and of the splendid forests of the deodar, a pine that grows to gigantic size even in the snow.

According to Captain and Mr. Gerard the line of perpetual congelation is at an elevation of only 12,800 feet on the southern slopes of the Himalaya, while on the northern side it is 15,600 feet above the sea—a remarkable circumstance, which is ascribed to the fogs that rise from the plains of Hindostan on one hand, and the serenity that prevails on the other: something may be due to radiation from the high northern plains, which, being so near, have much greater effect on the temperature than the warmer but more distant plains on the south.

Four vast secondary chains leave the Himalaya at the great mountain-knot at the sources of the Brahmapootra, in the Chinese province of Yunnan, and extend through the Indo-Chinese peninsula and the countries east of the Ganges,



in a southern but diverging direction, leaving large and fertile kingdoms between them. The Birmano-Siamese chain is the most extensive, reaching to the extremity of the Malayan peninsula at Cape Romania, the most southerly point of Asia; it may be traced through the island of Sumatra parallel to the coast, and also in the islands of Banka and Beliton, where it ends.

Another range, called the Laos-Siamese chain, forms the eastern boundary of the kingdom of Siam, and the Annamatic chain, from the same origin, separates the empire of Annam from Tonquin and Cochin China.

These slightly diverging lines of mountains yield gold, silver, tin, of the best quality, in great plenty, almost on the surface, and precious stones, as rubies and sapphires. Mountains in low latitudes have nothing of the severe character of those in less favoured climes. Magnificent forests reach their summit; spices, dyes of brilliant tints, medicinal and odoriferous plants clothe these declivities; and in the low grounds the fruit of India and China grow in perfection in a soil which yields three crops of grain in the year.

The crest of the Himalaya is of stratified crystalline rocks, especially gneiss, with large granitic veins, and beds of quartz of huge magnitude. The zone, between 15,000 and 18,000 feet above the level of the sea, is of silurian strata, below which sandstone prevails: granite is most frequent at the base, and probably forms the foundation of the chain. Strata of comparatively modern date occur at great elevations. These sedimentary formations, prevailing also on the acclivities of the Alps and Apennines, show that the epochs of elevation in parts of the earth widely remote from one another, if not simultaneous, were at least not very different. There can be no doubt that very great geological changes have taken place at a comparatively recent period in the Himalaya, and through an extensive part of the Asiatic continent.

The Altaï mountains, which form the northern margin of the table-land, are unconnected with the Ural chain: they are separated from it by 400 miles of a low marshy country, part of the steppe of the Kirghiz, and by the Dalai mountains, a low range never above 2000 feet high, which runs between the 64th meridian and the left bank of the Irtysh. The Altaï chain begins on the right bank of that river at the north-west



angle of the table-land, and extends in a serpentine line to the Pacific, south of the Gulf of Okhotzk, dividing the high lands of Tartary and China from the wastes of Asiatic Siberia. Under the name of the Aldan Mountains it skirts the north-west side of the Gulf of Okhotzk, and then stretches to Behring's Straits, its length being 4500 miles. The breadth of this chain varies from 400 to 1000 miles, but towards the 105th meridian it is contracted to about 150, by a projection of the desert of the Great Gobi. Its height bears no proportion to its length and breadth. Indeed the Little Altaï, the only part of the chain properly so called lying between the Irtysh and the 86th degree of east longitude, can only be regarded as a succession of terraces of a swelling outline, descending by steps from the table-land, and ending in promontories on the Siberian plains. There are numerous large lakes on these terraces and on the mountain valleys, as in the mountain systems of Europe. The general form of this part of the chain is monotonous from the prevalence of straight lines and smooth rounded outlines. Long ridges with flattened summits, or small table-lands, not more than 6000 feet high, is their usual structure, rarely attaining the line of perennial congelation: snow however is permanent on the Korgon table-land, 9900 feet above the sea, supposed to be the culminating point of this part of the chain. These table-lands bear a strong resemblance to those in the Scandinavian mountains in baldness and sterility, but their flanks are clothed with forests, verdant meadows, and pastoral valleys.

East of the 86th meridian this region of low mountains splits into three branches, inclosing longitudinal valleys for 450 miles. The central chain, called the Tongnou Oola, may be regarded as the principal continuation of the Altaï: it lies nearly along the 50th parallel of latitude, but, bending northwards, passes between the lakes Kossagol and Baikal under the name of the Sayansk Mountains. The granite range of the Baikal, properly so called, meets the Sayansk chain nearly at right angles, and unites it with the mountains of the Upper Angara. At the point where the axes of the Baikal and Sayansk chains cross, the mountains are highest, and there only the Altaï assumes the form of a regular chain. The principal part of the Baikal group is 500 miles long, from 10 to 60 wide, high and snow-capped, but without glaciers. It flanks Lake Baikal on the north,



the largest of Alpine lakes, so imbedded in a knot of mountains, partly granitic, partly volcanic, that rocks and pillars of granite rise from its bed. The mountains south of the lake are but the face of the table-land ; a traveller ascending them finds himself at once in the desert of Gobi, which stretches in unbroken sadness to the Great Wall of China.

The Daouria Mountains, a volcanic portion of the Altaï, which borders the table-land on the north-east, follow the Baikal chain ; and farther east, at the sources of the Aldan, the Altaï range takes the name of the Yablonnoi Khrebet, and stretches south of the Gulf of Okhotzk to the coast of the Pacific, opposite to the island of Tarakai ; while another part, 1000 miles broad, fills the space between the Gulf of Okhotzk and the river Lena, and then, bending to the north-east, ends in the peninsula of Kamtschatka.

A great portion of the Altaï chain is unknown to Europeans ; the innumerable branches that penetrate the Chinese empire are completely so : those belonging to Russia abound in a great variety of precious and rare metals and minerals—silver, copper, and iron. In the Yablonnoi range and other parts there are whole mountains of porphyry, with red and green jasper ; coal is also found ; and in a branch of the Altaï, between the rivers Obi and Yenissei, there are mines of coal which were set on fire by lightning, and have continued to burn more than a century. The Siberian mountains far surpass the Andes in the richness of their gold-mines. The eastern flank of the Ural chain, and some of the northern spurs of the Altaï, have furnished an immense quantity, but a region as large as France has lately been discovered in Siberia covered with the richest gold alluvium, lying above rocks filled with that precious metal. The mines of the Ural and Altaï are in metamorphic schists adjacent to the greenstones, syenites, and serpentines that have caused their change ; and as the same formation prevails throughout the greater part of the Altaï and Aldan chains almost to Kamtschatka, there is every reason to believe that the whole of that vast region is auriferous : besides, as many of the northern offsets of the Altaï are particularly rich, it may be concluded that the southern branches in the Chinese empire are equally so. Thus all southern Siberia and Chinese Tartary form an auriferous district probably greater than all Europe, which extends even to our dominions in Hindostan, where the gold formations are unexplored.



The sedimentary deposits in this extensive mountain-range are more ancient than the granite, syenite, and porphyries; consequently these igneous rocks have not here formed part of the original crust of the globe. Rocks of the Paleozoic series occupy the greater part of the Altaï, and probably there are none more modern. There are no volcanic rocks, ancient or modern, west of the Yenesei, but they abound to the east of that river, even to Kamtschatka, which is full of them.

The physical characters and the fossil remains of this extensive mountain system have little relation with the geological formations of Europe and America. Eastern Siberia seems even to form an insulated district by itself, and that part between the town of Yakoutzk and the mouth of the Lena appears to have been raised at a later period than the part of Siberia stretching westward to the Sayanok Mountains: moreover the elevation of the Little Altaï was probably contemporaneous with that of the Ural Mountains.

Little more is known of the eastern boundary of the table-land of Tibet than that between the sources of the Brahmapootra and the Altaï chain nearly a million of square miles of the Chinese empire are covered with mountains, which begin under the 98th meridian at the edge of the table-land, and descend to the 112th degree of east longitude in southern China, and to the 114th degree in the north. The eastern boundary of this mountainous region is said to be the chains of the In-Shan and Khing-Khan Oolas. The former begins at the southern extremity of Tartary, near the Yellow River, and maintains a very tortuous course to the snow-clad mountains of Petsha, 15,000 feet high. It then goes north, under the name of the Khing-Khan Oola, in a serrated granitic chain, separating the table-land of Mongolia from the country of the Manchoux, and joins the Yablonnoi branch of the Altaï at right angles about the 55th degree of north latitude.

The table-land of Tibet is only 4000 feet above the sea towards the north, but it rises in Little Tibet to between 11,000 and 12,000 feet. The Kuen-luen, the most southerly of the two diagonal mountain-chains that cross the table-land, begins at the Hindoo Coosh, in latitude  $35^{\circ} 30'$ , and extends eastward in two branches, which again unite in the K'han of eastern Tibet, nearly in the centre of the table-land, where they form an elevated mountain plain round



the Lake of Koko-Nor, from whence those immense mountain-ranges diverge which render the south-western provinces of China the most elevated region on earth. The country of Tibet lying between the Himalaya and the Kuen-luen consists of rocky mountainous ridges, extending from N.W. to S.E., separated by long valleys, in which flow the upper courses of the Brahmapootra, Sutlej, and Indus. According to Mr. Moorcroft, the sacred lake Manasa, in Great Tibet, and the surrounding country, is 17,000 feet above the sea, which is 1270 feet higher than Mont Blanc. In this elevated region the sheltered valleys and the borders of the streams alone are available for agriculture; and as the summer sun is powerful, wheat and barley grow, and many of the fruits of Southern Europe ripen. The city of H'Lassa, in eastern Tibet, the residence of the Grand Lama, is surrounded by vineyards, and is called by the Chinese the "Realm of Pleasure." There are no trees in this country, and the ground in cultivation bears a small proportion to the grassy steppes, which extend in endless monotony, grazed by thousands of the shawl-wool goats, sheep, and cattle. There are many lakes in the table-land; some in Ladok contain borax, a salt very useful in the arts, found only here and at Corbali in Tuscany, and the Lipari islands.

In summer the sun is powerful at midday, the air is of the purest transparency, and the azure of the sky so deep that it seems black as in the darkest night. The rising moon does not enlighten the atmosphere, no warning radiance announces her approach, till her limb touches the horizon, and the stars shine with the distinctness and brilliancy of suns. In southern Tibet the verdure is confined to favoured spots, the bleak mountains and high plains are sternly gloomy—a scene of barrenness not to be conceived. Solitude reigns in these dreary wastes, where there is not a tree nor even a shrub to be seen of more than a few inches height. The scanty, short-lived verdure vanishes in October, the country looks as if fire had passed over it, and cutting dry winds blow with irresistible fury, howling in the bare mountains, whirling the snow through the air, and freezing to death the unfortunate traveller benighted in their defiles.

Yarkand and Khotan, provinces of Chinese Tartary, which lie beyond the two diagonal chains, are less elevated and more fertile than Tibet. They are watered by five rivers, and



contain several large cities ; Yarkand, the most considerable of these, is the emporium of commerce between Tibet, Turkistan, China, and Russia. Gold, rubies, silk, and other productions are exported.

The Tartar range of the Thian-Shan is very high ; the Bogda Oola, or Holy Mountain, near Lake Lop, its highest point, is always covered with snow ; and it has two active volcanoes, one on each side—a solitary instance of volcanic vents so far from the sea. This range runs along the 42d parallel of north latitude, forming at its western extremity a mountain-knot with the Beloot Tagh, in the centre of which lies the small table-land of Pamere, 15,600 feet high, called by the natives the “Roof of the World.” Its remarkable elevation was first observed by the enterprising Venetian traveller, Marco Paolo, six centuries ago. The Oxus originates in a glacier of the Pooshtee Khur, a peak of the Beloot Tagh, near the plain of Pamere ; and the lake Sir-i-Kol is here the source of the Yarkand, and the Kokan also rises from this plain, which is intensely cold in winter, and in summer is alive with flocks of sheep and goats.

Zungary, or Mongolia, the country between the Thian-Shan and the Altaï, is hardly known further than that its grassy steppes, intersected by many lakes and offsets from the Altaï, are the pasture-grounds of the wandering Kirghis.

The remarkable feature of the table-land is the desert of the Great Gobi, which occupies an area of 300,000 square miles in its eastern extremity, interrupted only by a few spots of pasture and low bushes. Wide tracts are flat and covered with small stones or sand, and at a great distance from one another there are low hills, destitute of wood and water ; its general elevation is about 4000 feet above the sea, but it is intersected from west to east by a depressed valley aptly named Shamo, or the “Sea of Sand,” which is also mixed with salt. West from it lies the Han-Hai, the “Dry Sea,” a barren plain of shifting sand blown into high ridges. Here, as in all deserts, the summer sun is scorching, the winter’s cold intolerable. All the plains of Mongolia are intensely cold, because the hills to the north are too low to screen them from the polar blast, and, being higher than the Siberian deserts, they are bitterly cold ; no month in the year is free from frost and snow, yet it is not deep enough to prevent cattle from finding pasture. Sandy



deserts like that of the Great Gobi occupy much of the country south of the Chinese branches of the Altaï.

Such is the stupendous zone of high land that girds the old continent throughout its whole length. In the extensive plains on each side of it several independent mountain systems rise, though much inferior to it in extent and height.

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## CHAPTER V.

SECONDARY MOUNTAIN SYSTEMS OF THE GREAT CONTINENT—  
THAT OF SCANDINAVIA—GREAT BRITAIN AND IRELAND—  
THE URAL MOUNTAINS—THE GREAT NORTHERN PLAIN.

THE great northern plain is broken by two masses of high land, in every respect inferior to those described: they are the Scandinavian system and the Ural Mountains, the arbitrary limit between Europe and Asia.

The range of primary mountains which has given its form to the Scandinavian peninsula begins at Cape Lindesnaes, the most southerly point of Norway, and, after running along its western coast 1000 miles in a north-easterly direction, ends at Cape Nord Kyn on the Polar Ocean, the extremity of Europe. The highest elevation of this chain is not more than 8412 feet. It has been compared to a great wave or billow, rising gradually from the east, which, after having formed a crest, falls perpendicularly into the sea in the west. There are 3696 square miles of this peninsula above the line of perpetual snow.

The southern portion of the chain consists of ridges following the general direction of the range, 150 miles broad. At the distance of 360 miles from Cape Lindesnaes the mountains form a single elevated mass, terminated by a table-land, which maintains an altitude of 4500 feet for 100 miles. It slopes towards the east, but plunges at once in high precipices into a deep sea on the west.

The surface is barren, marshy and bristled with peaks; besides, an area of 600 square leagues is occupied by the Snae Braen, the greatest mass of perpetual snow and glaciers on the continent of Europe. A prominent cluster of moun-



tains follows, from whence a single chain, 25 miles broad, maintains an uninterrupted line to the island of Megaree, where it terminates in North Cape, a huge barren rock perpetually lashed by the surge of the Polar Ocean. Offsets from these mountains cover Finland and the low rocky table-land of Lapland: the valleys and countries along the eastern side of the chain abound in forests and Alpine lakes.

The iron-bound coast of Norway is a continued series of rocky islands, capes, promontories, and precipitous cliffs, rent into chasms which penetrate miles into the heart of the mountains. These chasms, or fiords, are either partly or entirely filled by arms of the sea; in the former case the shores are fertile and inhabited. Fiords are not peculiar to the coast of Norway; they are even more extensive in Greenland and Iceland, and of a more stern character, overhung by snow-clad rocks and glaciers.

As the Scandinavian mountains, those of Feroe, Britain, Ireland, and the north-eastern parts of Iceland have a similar character, and follow the same general directions, they must have been elevated by forces acting in parallel lines, and therefore may be regarded as belonging to the same system.

The Feroe islands, due west from Norway, rise at once in a table-land 2000 feet high, bounded by precipitous cliffs, which dip into the ocean. Some parts of these islands are gradually sinking below their former level; indeed there seems to be an extraordinary flexibility in the crust of the earth in these high northern latitudes; it is bending below its former level in south Sweden, Feroe, and the west coast of Greenland, or in a zone between the 55th and 62d or 63d parallels, while the coast of Norway is rising at the rate of four feet in a hundred years from Sölvitsberg northward to Lapland, where the elevation is greatest.

The rocky islands of Zetland and those of Orkney form part of the mountain system of Scotland: the Orkney islands have evidently been separated from the mainland by the Pentland Firth, where the currents run with prodigious violence. The north-western part of Scotland is a table-land from 1000 to 2000 feet high, which ends abruptly in the sea, covered with heath, peat-mosses, and pasture. The general direction of the Scottish mountains, like those of Scandinavia, is from north-east to south-west, divided by a long line of lakes in the same direction, extending from



the Moray Firth completely across the island to south of the island of Mull. Lakes of the most picturesque beauty abound among the Scottish mountains. The Grampian hills, with their offsets and some low ranges, fill the greater part of Scotland north of the Clyde and Forth. Ben Nevis, only 4374 feet above the sea, is the highest hill in the British islands.

The east coast of Scotland is generally bleak, though in many parts it is extremely fertile, and may be cited as a model of good cultivation; and the midland and southern counties are not inferior either in the quality of the soil or the excellence of the husbandry. To the west the country is wildly picturesque; the coast of the Atlantic, penetrated by the sea, which is covered with islands, bears a strong resemblance to that of Norway.

There cannot be a doubt that the Hebrides formed part of the mainland at some remote geological period, since they follow the direction of the mountain system in two parallel lines of rugged and imposing aspect, never exceeding the height of 3200 feet. The undulating country on the borders of Scotland becomes higher in the west of England and North Wales, where the hills are wild, but the valleys are cultivated like a garden, and the English lake scenery is of the most gentle beauty.

Evergreen Ireland is mostly a mountainous country, and opposes to the Atlantic storms an iron-bound coast of the wildest aspect; but it is rich in arable land and pasture, and possesses the most picturesque lake scenery; indeed, fresh-water lakes in the mountain valleys, so peculiarly characteristic of the European system, are the great ornaments of the high lands of Britain.

Various parts of the British islands were dry land while most of the continent of Europe was yet below the ancient ocean. The high land of Lammermuir, the Grampian hills in Scotland, and those of Cumberland in England, were raised before the Alps had begun to appear above the waves. In general all the highest parts of the British mountains are of granite and stratified crystalline rocks. The primary fossiliferous strata are of immense thickness in Cumberland and in the north of Wales, and the old red sandstone, many hundred feet thick, stretches from sea to sea along the flanks of the Grampians. The coal strata are developed on a great



scale in the south of Scotland and the north of England, and examples of every formation, with one exception, are to be found in these islands. Volcanic fires had been very active in early times, and nowhere is the columnar structure more beautifully exhibited than in Fingal's Cave and the Storr of Sky in the Hebrides; and in the north of Ireland a base of 800 square miles of mica slate is covered with volcanic rocks, which end on the coast in the magnificent columns of the Giant's Causeway.

The Ural chain, the boundary between Europe and Asia, is the only interruption to the level of the great northern plain, and is altogether unconnected with, and far separated from, the Altai Mountains by salt lakes, marshes, and deserts. The central ridge may be traced from between the Lake of Aral and the Caspian Sea; but as a chain it really begins on the right bank of the Ural river at the steppes of the Kirghis, about the 51st degree of north latitude, and runs due north in a long narrow ridge to the Gulf of Kara in the Polar Ocean, though it may be said to terminate in dreary rocks on the west side of Nova Zembla. The Ural range is about the height of the mountains in the Black Forest or the Vosges, and, with few exceptions, is wooded to the top, chiefly by the *pinus cembra*. The immense mineral riches of these mountains—gold, platina, magnetic iron, and copper—lie on the Siberian side, and chiefly between the 54th and 60th degrees of north latitude, the only part that is colonized, and one of the most industrious and civilized regions of the Russian empire. To the south the chain is pastoral, about 100 miles broad, consisting of longitudinal ridges, the highest of which does not exceed 3498 feet; in this part diamonds are found. To the north of the mining district the narrow mural mass, which is at most but 5720 feet above the sea-level, is covered with impenetrable forests and deep morasses, altogether uninhabitable and unexplored. Throughout the Ural Mountains there are neither precipices, transverse gorges, nor any of the characteristics of a high chain: the descent on both sides is so gentle that in many places it is difficult to know where the plain begins; and the road over the chain from Russia to Siberia by Ekaterinburg is so low that it hardly seems to be a mountain pass. The gentle descent and sluggishness of the streams produce extensive marshes along the Siberian base of the range. To the arduous and



enterprising researches of Sir Roderick Murchison we are indebted for almost all we know of these mountains; he found them on the western side to be composed of silurian, devonian, and carboniferous rocks more or less altered and crystallized; and on the eastern side the mines are in metamorphic strata, mixed with rocks of igneous origin, and the central axis is of quartzose and chloritic rocks.

The great zone of high land which extends along the old continent from the Atlantic to the shores of the Pacific Ocean divides the low lands into two very unequal parts. That to the north, only broken by the Ural range, and the Valdai table-land of still less elevation, stretches from the Thames or the British hills and the eastern bank of the Seine to Behring's Straits, including more than  $190^{\circ}$  of longitude, and occupying an area of at least four millions and a half of square geographical miles, which is a third more than all Europe. The greater part of it is perfectly level, with a few elevations and low hills, and in many places a dead level extends hundreds of miles. The country between the Carpathian and Ural Mountains is a flat, on which there is scarcely a rise in 1500 miles, and in the steppes of southern Russia and Siberia the extent of level ground is immense. The mean absolute height of the flat provinces of France is 480 feet; Moscow, the highest point of the European plain, is also 480 feet high, from whence the land slopes imperceptibly to the sea both on the north and south, till it absolutely dips below its level. Holland, on one side, would be overflowed were it not for its dykes, and towards Astrakan the plain sinks still lower. The whole of that extensive country north and east of the Caspian Sea, and around the lake of Aral, forms a vast cavity of 18,000 square leagues, all considerably below the level of the ocean; and the surface of the Caspian Sea itself, the lowest point, has a depression of 348 feet.

The European part of the plain is highly cultivated and very productive in the more civilized countries in its western and middle regions and along the Baltic. The greatest amount of cultivated land lies to the north of the watershed which stretches from the Carpathians to the centre of the Ural chain; yet there are large heaths which extend from the extremity of Jutland through Lunebourg and Westphalia to Belgium. The land is of excellent quality to the south of it. Round Polkova and Moscow there is an extent of the



finest vegetable mould, equal in size to France and the Spanish peninsula together, which forms part of the High Steppe, and is mostly in a state of nature.

A large portion of the great plain is pasture-land, and wide tracts are covered with natural forests, especially in Poland and Russia, where there are millions of acres of pine, fir, and deciduous trees.

The quantity of waste land in Europe is very great, and there are also many swamps; a morass as long as England extends along the 52d parallel of latitude, following the course of the river Prepit, a branch of the Dniestre, which runs through its centre. There are swamps at the mouths of many of the sluggish rivers in central Europe; they cover 1970 square miles in Denmark, and mossy quagmires occur frequently in the more northerly parts.

Towards the eastern extremity of Europe the great plain assumes the peculiar character of desert called a steppe, a word supposed to be of Tartar origin, signifying a level waste destitute of trees; hence the steppes may vary according to the nature of the soil. They begin at the river Dnieper, and extend along the shores of the Black Sea: they include all the country north and east of the Caspian Lake and Independent Tartary, and, passing between the Ural and Altai Mountains, they may be said to occupy all the low lands of Siberia. Hundreds of leagues may be traversed east from the Dnieper without variation of scene; a dead level of thin but luxuriant pasture, bounded only by the horizon, day after day the same unbroken monotony fatigues the eye: sometimes there is the appearance of a lake, which vanishes on approach, the phantom of atmospheric refraction. Horses and cattle beyond number give some animation to the scene so long as the steppes are green, but winter comes in October, and then they become a trackless field of spotless snow. Fearful storms rage, and the dry snow is driven by the gale with a violence which neither man nor animal can resist, while the sky is clear and the sun shines cold and bright above the earthly turmoil. The contest between spring and winter is long and severe, for—

“ Winter oft at once resumes the breeze,  
Chills the pale morn, and bids his driving sleets  
Deform the day, delightless.”



Yet when gentler gales succeed, and the waters run off in torrents through the channels which they cut in the soft ground, the earth is again verdant. The scorching summer's sun is as severe in its consequences in these wild regions as the winter's cold: in June the steppes are parched, no shower falls, nor does a drop of dew refresh the thirsty and rent earth: the sun rises and sets like a globe of fire, and during the day he is obscured by a thick mist from the evaporation. In some seasons the drought is excessive; the air is filled with dust in impalpable powder; the springs become dry, and cattle perish in thousands. Death triumphs over animal and vegetable nature, and desolation tracks the scene to the utmost verge of the horizon, a hideous wreck.

Much of this country is covered by an excellent but thin soil, fit for corn, which grows luxuriantly wherever it has been tried; but a stiff cold clay at a small distance below the surface kills every herb that has deep roots, and no plants thrive but those which can resist the extreme vicissitudes of climate. A very wide range is hopelessly barren; the country from the Caucasus along the shores of the Black and Caspian Seas, a dead flat twice the size of the British islands, is desert and destitute of fresh water. An efflorescence of salt covers the surface like hoar-frost; even the atmosphere and the dew are saline, and many salt-lakes in the neighbourhood of Astrakan furnish great quantities of common salt and nitre. Saline plants, with patches of verdure few and far between, are the only signs of vegetable life, but about Astrakan there is soil and cultivation. Some low hills occur in the country between the Caspian and the Lake of Aral, but it is mostly an ocean of shifting sand, often driven by appalling whirlwinds.

Turkistan is a sandy desert, except on the banks of the Oxus and the Jaxartes, and as far on each side of them as canals convey the fertilizing waters. To the north barrenness gives place to verdure between the Ural river and the terraces and mountains of central Asia, where the steppes of the Kirghis afford pasture to thousands of camels and cattle belonging to these wandering hordes.

Siberia is either a dead level or undulating surface of more than 7,000,000 of square miles, between the North Pacific and the Ural Mountains, the Polar Sea and the Altai range, whose terraces and offsets end in those plains, like



headlands and promontories in the ocean. M. Middendorf, indeed, met with a chain of most desolate mountains on the shores of the Polar Ocean, in the country of the Samoides; and the almost inapproachable coast far to the east is unexplored. The mineral riches of the mountains have brought together a population who inhabit towns of considerable importance along the base of the Ural and Altaï chains, where the ground yields good crops and pasture; and there are forests on the undulations of the mountains and on the plains. There are many hundred square miles of rich black mould covered with trees and grass, uninhabited, between the river Tobal and the upper course of the Obi, within the limit where corn would grow; but even this valuable soil is studded with small lakes of salt and fresh water, a chain of which, 300 miles long, skirts the base of the Ural Mountains.

North of the 62d parallel of latitude corn does not ripen, on account of the biting blasts from the Icy Ocean which sweep supreme over these unprotected wastes. In a higher latitude even the interminable forests of gloomy fir are seen no more; all is a wide-spreading desolation of salt steppes, boundless swamps, and lakes of salt and fresh water. The cold is so intense there that the spongy soil is perpetually frozen to the depth of some hundred feet below the surface; and the surface itself, not thawed before the end of June, is again ice-bound by the middle of September, and deep snow covers the ground nine or ten months in the year. Happily gales of wind are not frequent during winter, but when they do occur no living thing ventures to face them. The sun, though long absent from these dismal regions, does not leave them to utter darkness; the extraordinary brilliancy of the stars, and the gleaming snow-light, produce a kind of twilight, which is augmented by the splendid coruscations of the Aurora Borealis.

The scorching heat of the summer's sun produces a change like magic on the southern provinces of the Siberian wilderness. The snow is scarcely gone before the ground is covered with verdure, and flowers of various hues blossom, bear their seed, and die in a few months, when winter resumes his empire. A still shorter-lived vegetation scantily covers the plains in the far north, and, on the shores of the Icy Ocean, even reindeer-moss grows scantily.



The abundance of fur-bearing animals in the less rigorous parts of the Siberian deserts has tempted the Russians to colonize and build towns on these frozen plains. Yakutsk, on the river Lena, in  $62^{\circ} 1' 30''$  N. latitude, is probably the coldest town on earth. The ground is perpetually frozen to the depth of more than 400 feet, of which three feet only are thawed in summer, when Fahrenheit's thermometer is frequently  $77^{\circ}$  in the shade; and as there is sometimes no frost for four months, larch forests cover the ground, and wheat and rye produce from fifteen to forty fold. In winter the cold is so intense that mercury is constantly frozen two months, and occasionally even three.

In the northern parts of Europe the silurian, devonian, and carboniferous strata are widely developed, and more to the south they are followed in ascending order by immense tracts of the higher series of secondary rocks, abounding in the huge monsters of a former world. Very large and interesting tertiary basins fill the ancient hollows in many parts of the plain, which are crowded with the remains of animals that no longer exist. Of these the most important are the London, Paris, Brussels, and Moscow basins, with many others in the north of Germany and Russia, and alluvial soil covers the greater part of the plain. In the east Sir Roderick Murchison has determined the boundary of a region twice as large as France, extending from the Polar Ocean to the southern steppes, and from beyond the Volga to the flanks of the Ural chain, which consists of a red deposit of sand and marl, full of copper in grains, belonging to the Permian system. This, and the immense tract of black loam already mentioned, are the principal features of eastern Europe.

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## CHAPTER VI.

### THE SOUTHERN LOW LANDS OF THE GREAT CONTINENT, WITH THEIR SECONDARY TABLE-LANDS AND MOUNTAINS.

THE low lands to the south of the great mountain girdle of the old continent are much broken by its offsets, by separate groups of mountains, and still more by the deep



indentation of bays and large seas. Situate in lower latitudes, and sheltered by mountains from the cutting Siberian winds, these plains are of a more tropical character than those to the north; but they are strikingly contrasted in their different parts,—either rich in all the exuberance that heat, moisture, and soil can produce, or covered by wastes of bare sand,—in the most advanced state of cultivation, or in the wildest garb of nature.

The barren parts of the low lands lying between the eastern shores of China and the Indus bear a small proportion to the riches of a soil vivified by tropical warmth, and watered by the periodical inundations of the mighty rivers that burst from the icy caverns of Tibet and the Himalaya. On the contrary, the favoured regions on that part of the low land lying between the Persian Gulf, the Euphrates, and the Atlas Mountains, are small when compared with the immense expanse of the Arabian and African deserts, calcined and scorched by an equatorial sun. The blessing of a mountain zone, pouring out its everlasting treasures of moisture, the life-blood of the soil, is nowhere more strikingly exhibited than in the contrast formed by these two regions of the globe.

The Tartar country of Mandshur, watered by the river Amour, but little known to Europeans, lies immediately south of the Yablonnoi branch of the Altaï chain, and consequently partakes of the desert aspect of Siberia, and, in its northern parts, even of the Great Gobi. It is partly intersected by mountains, and covered by dense forests; nevertheless, oats grow in the plains, and even wheat in sheltered places. Towards Corea the country is more fertile; in that peninsula there are cultivated plains at the base of its central mountain-range.

China is the most productive country on the face of the earth; an alluvial plain of 210,000 square miles, formed by one of the most extensive river systems in the old world, occupies its eastern part. This plain, seven times the size of Lombardy, is no less fertile, and perfectly irrigated by canals. The great canal traverses the eastern part of the plain for 700 miles, of which 500 are in a straight line of considerable breadth, with a current in the greater part of it. Most part of the plain is in rice and garden ground, the whole cultivated with the spade. The tea-plant grows on a low range of hills between the 30th and 32d parallels of



north latitude, an offset from the Pe-ling chain. The cold in winter is much greater than in corresponding European latitudes, and the heat in summer is proportionally excessive.

The Indo-Chinese peninsula, lying between China and the river Brahmapootra, has an area of 77,700 square miles, and projects 1500 miles into the ocean. The plains lying between the offsets descending from the east end of the Himalaya, and which divide it longitudinally, as before mentioned, are very extensive. The Birman empire alone, which occupies the valley of the Irrawaddy, is said to be as large as France, and not less fertile, especially its southern part, which is the granary of the empire. Magnificent rivers intersect the alluvial plains, whose soil they have brought down from the table-land of Tibet, and still continue to deposit in great quantities in the deltas at their mouths.

The plains of Hindostan extend 2000 miles along the southern slope of the Himalaya and Hindoo Coosh, between the Brahmapootra and the Indus, and terminate on the south in the Bay of Bengal, the table-land of the Decan, and the Indian Ocean — a country embracing in its range every variety of climate, from tropical heat and moisture to the genial temperature of southern Europe.

The valley of the Ganges is one of the richest on the globe, and contains a greater extent of vegetable mould, and of land under cultivation, than any other country in this continent, except perhaps the Chinese empire. In its upper part, Sirhind and Delhi, the seat of the ancient Mongol empire, still rich in splendid specimens of Indian art, are partly arid, although in the latter there is fertile soil. The country is beautiful where the Jumna and other streams unite to form the Ganges. These rivers are often hemmed in by rocks and high banks, which in a great measure prevent the periodical overflow of the waters; this, however, is compensated by the coolness and moisture of the climate. The land gradually improves towards the east, as it becomes more flat, till at last there is not a stone to be seen for hundreds of miles down to the Gulf of Bengal. Wheat and other European grain is produced in the upper part of this magnificent valley, while in the south every variety of Indian fruit, rice, cotton, indigo, opium, and sugar, are the staple commodities. The ascent of the plain of the Ganges



from the Bay of Bengal is so gradual, that Saharampore, nearly at the foot of the Himalaya, is only 1100 feet above the level of Calcutta ; the consequence of which is, that the Ganges and Brahmapootra, with their branches, in the rainy season between June and September, lay Bengal under water for hundreds of miles in every direction, like a great sea. When the water subsides, the plains are verdant with rice and other grain ; but when harvest is over, and the heat intense, the scene is changed—the country, divested of its beauty, becomes parched and dusty everywhere, except in the extensive jungles. It has been estimated that one-third of the British territory in India is covered with these rank marshy tracts.

The peninsula of Hindostan is occupied by the triangular-shaped table-land of the Decan, which is much lower, and totally unconnected with the table-land of Tibet. It has the primary ranges of the Ghauts on the east and west, and the Vendhya Mountains on the north, sloping by successive levels to the plains of Hindostan Proper. The surface of the Decan, between 3000 and 4000 feet above the sea, is a combination of plains, ridges of rock, and insulated flat-topped hills, which are numerous, especially in its north-eastern parts. These solitary and almost inaccessible heights rise abruptly from the plains, with all but perpendicular sides, which can only be scaled by steps cut in the rock, or by very dangerous paths. Many are fortified, and were the strongholds of the natives, but they never have withstood the determined intrepidity of British soldiers.

The peninsula terminates with the table-land of the Mysore, 7000 feet above the sea, surrounded by hills 1500 higher.

The base of this plateau, and indeed of all the Decan, is granite, and there are also syenitic and trap rocks, with abundance of primary and secondary fossiliferous strata. Though possessing the diamond-mines of Golconda, the true riches of this country consist in its vegetable mould, which in the Mysore is a hundred feet thick, an inexhaustible source of fertility. The sea-coasts on the two sides of the peninsula are essentially different : that of Malabar is rocky, but in many parts well cultivated, and its high mountains are covered with forests ; whereas on the Coromandel coast the mountains are bare, and the wide maritime plains are for the most part parched.



The island of Ceylon, nearly equal in extent to Ireland, is almost joined to the southern extremity of the peninsula by sandbanks and small islands, between which the water is only six feet deep in spring tides. The Sanscrit name of the "Resplendent" may convey some idea of this island, rich and fertile in soil, adorned by lofty mountains, numerous streams, and primeval forests ; in addition to which it is rich in precious stones, and has the pearl-oyster on its coast.

The Asiatic low lands are continued westward from the Indian peninsula by the Punjab and the Great Indian Desert. The Punjab, or "country of the five rivers," lies at the base of the Hindoo Coosh. Its most northern part consists of fertile terraces, highly cultivated, and valleys at the foot of the mountains. It is very productive in the plain within the limits of the periodical inundations of the rivers, and where it is watered by canals ; in other parts it is pastoral. Lahore occupies the chief part of the Punjab ; and the city of that name on the Indus, once the rival of Delhi, lies on the high road from Persia to India, and was made the capital of the kingdom by Runjeet Sing. The valley of the Indus throughout partakes of the character of the Punjab ; it is fertile only where it is within reach of water ; much of it is delta, which is occupied by rice-grounds ; the rest is pasture, or sterile salt marshes.

South of the Punjab, and between the fertile plains of Hindostan and the left banks of the Indus, lies the Great Indian Desert, which is about 400 miles broad, and becomes more and more arid as it approaches the river. It consists of a hard clay, covered with shifting sand, driven into high waves by the wind, with some parts that are verdant after the rains. In the province of Cutch, south of the desert, a space of 7000 square miles, known as the Run of Cutch, is alternately a sandy salt desert and an inland sea. In April the waves of the sea are driven over it by the prevailing winds, leaving only a few grassy eminences, the resort of wild asses. The Desert of Mekram, an equally barren tract, extends along the Gulf of Oman from the mouths of the Indus to the Persian Gulf ; in some places, however, it produces the Indian palm and the aromatic shrubs of Arabia Felix.

The scathed shores of the Arabian Gulf, where not a blade of grass freshens the arid sands, and the not less barren



valley of the Euphrates and Tigris, except where the floods of these rivers irrigate the soil, separate Asia from Arabia and Africa, the most desert regions in the old world.

The peninsula of Arabia, divided into two parts by the tropic of Cancer, is about four times the size of France. No rivers, and few streams or springs, nourish this thirsty land, whose barren sands are scorched by a fierce sun. The central is a table-land of moderate height, which, however, is said to have an elevation of 8000 feet in the province of Haudramaut. To the south of the tropic it is an almost interminable ocean of drifting sand, wafted in clouds by the gale, and dreaded even by the wandering Beduin. At wide intervals, long, narrow depressions cheer the eye with brush-wood and verdure. More to the north, mountains and hills cross the peninsula from S.W. to N.E., inclosing cultivated and fine pastoral valleys, adorned by groves of the date-palm and aromatic shrubs. Desolation once more resumes its domain where the table-land sinks into the Syrian desert, and throughout the rest of its circumference it descends in terraces or parallel ranges of mountains and hills to a flat sandy coast, from 30 to 100 miles wide, which surrounds the greater part of the peninsula, from the mouths of the Euphrates to the Isthmus of Suez. The hills come close to the beach in the province of Oman, which is traversed by chains, and broken into piles of arid mountains, not more than 3500 feet high, with the exception of the Jebel Okkdar, which is 6000 feet above the sea, and is cleft by temporary streams and fertile valleys. Here the ground is cultivated and covered with verdure, and still farther south there is a line of oases fed by subterraneous springs, where the fruit common to Persia, India, and Arabia are produced.

The south-eastern coast is scarcely known, except towards the provinces of Haudramaut and Yemen, or Arabia Felix, where ranges of mountains, some above 5000 feet high, line the coast, and in many places project into the ocean, sometimes forming excellent harbours, as that of Aden, which is protected by jutting rocks. In the intervals there are towns and villages, cotton-trees, date-groves, and cultivated ground.

On the northern side of these granite ranges, where the table-land is 8000 feet above the sea, and along the edge of the desert of El Aklaj, in Haudramaut, there is a tract of sand so loose and so very fine, that a plummet was sunk in



it by Baron Wrede to the depth of 360 feet without reaching the bottom. There is a tradition in the country that the army of King Suffi perished in attempting to cross this desert. Arabia Felix, which merits its name, is the only part of that country with permanent streams, though they are small. Here also the mountains and fertile ground run far inland, producing grain, pasture, coffee, odoriferous plants, and gums. High cliffs line the shores of the Indian Ocean and the Strait of Babelman-deb, "the Gate of Tears." The fertile country is continued a considerable way along the coast of the Red Sea, but the character of barrenness is resumed by degrees, till at length the hills and intervening terraces, on which Mecca and Medina, the holy cities of the Mahomedans, stand, are sterile wastes wherever springs do not water them. The blast of the desert, loaded with burning sand, sweeps over these parched regions. Mountains skirt the table-land to the north; and the peninsula between the Gulfs of Akaba and Suez on the Red Sea, the Eliath of Scripture, is filled by the mountain-groups of Sinai and Horeb. Jebel Housa, Mount Sinai, on which Moses received the Ten Commandments, is 9000 feet high, surrounded by higher mountains, which are covered with snow in winter. The group of Sinai is full of springs, and verdant. At its northern extremity lies the desert of El-Teh, 70 miles long and 30 broad, in which the Israelites wandered forty years. It is covered with long ranges of high rocks, of most repulsive aspect, rent into deep clefts only a few feet wide, hemmed in by walls of rock sometimes 1000 feet high, like the deserted streets of a Cyclopean town. The whole of Arabia Petrea, Edom of the sacred writers, presents a scene of appalling desolation, completely fulfilling the denunciation of prophecy.

A sandy desert, crossed by low limestone ridges, separates the table-land of Arabia from the habitable part of Syria, which the mountains of Lebanon divide into two narrow plains. These mountains may almost be considered offsets from the Taurus chain; at least they are joined to it by the wooded range of Gawoor, the ancient Amanus, impassable except by two defiles, celebrated in history as the Amanic and Syrian Gates. The group of Lebanon begins with Mount Cavius, which rises abruptly from the sea in a single peak to the height of 7000 feet, at the mouth of the river Orontes. From thence the chain runs south, at a distance of about 20



miles from the shores of the Mediterranean, in a continuous line of peaks to the sources of the Jordan, where it splits into two nearly parallel naked branches, inclosing the wide and fertile plain of Beka or Ghor, the ancient Cælo-Syria, in which are the ruins of Balbec.

The Lebanon branch terminates at the sea near the mouth of the river Leontes, a few miles north of the city of old Tyre; while the Anti-Libanus, which begins at Mount Hermon, 9000 feet high, runs west of the Jordan through Palestine, in a winding line, till its last spurs, south of the Dead Sea, sink in ridges of rock on the desert of Sinai.

The tops of all these mountains, from Scanderoon to Jerusalem, are covered with snow in winter; it is permanent on Lebanon only, whose absolute elevation is 9300 feet. The precipices are terrific, the springs abundant, and the spurs of the mountains are studded with villages and convents; there are forests in the higher grounds, and lower down vineyards and gardens. Many offsets from the Anti-Libanus end precipitously on the coast between Tripoli and Berout, among which the scenery is superb.

The valleys and plains of Syria are full of rich vegetable mould, particularly the plain of Damascus, which is brilliantly verdant, though surrounded by deserts, the barren uniformity of which is relieved on the east by the broken columns and ruined temples of Palmyra and Tadmora. The Assyrian wilderness, however, is not everywhere absolutely barren. In the spring-time it is covered with a thin but vivid verdure, mixed with fragrant aromatic herbs, of very short duration. When these are burnt up, the unbounded plains resume their wonted dreariness. The country, high and low, becomes more barren towards the Holy Land, yet even here some of the mountains—as Carmel, Bashan, and Tabor—are luxuriantly wooded, and many of the valleys are fertile, especially the valley of the Jordan, which has the appearance of pleasure-grounds, with groves of wood and aromatic plants, but almost in a state of nature. One side of the Lake of Galilee is savage; on the other there are gentle hills and wild romantic vales, adorned with palm-trees, olives, and sycamores,—a scene of calm solitude and pastoral beauty. Jerusalem stands on a declivity encompassed by severe stony mountains, wild and desolate. The greater part of Syria is a desert compared with its ancient state. Mussulman rule



has blighted this fair region, once flowing with milk and honey,—the land of promise.

Farther south desolation increases; the valleys become narrower, the hills more denuded and rugged, till south of the Dead Sea their dreary aspect announces the approach to the desert.

The valley of the Jordan affords the most remarkable instance known of the depression of the land below the general surface of the globe. This hollow, which extends from the Gulf of Accabah on the Red Sea to the bifurcation of Lebanon, is 625 feet below the level of the Mediterranean at the Sea of Galilee, and the acrid waters of the Dead Sea have a depression of 1230 feet. The lowness of the valley had been observed by the Romans, who gave it the descriptive name of *Cœlo-Syria*, “Hollow Syria.” It is absolutely walled in by mountains between the Dead Sea and Lebanon, where it is from 10 to 15 miles wide.

A shrinking of the strata must have taken place along this coast of the Mediterranean from a sudden change of temperature, or perhaps in consequence of some of the internal props giving way, for the valley of the Jordan is not the only instance of a dip of the soil below the sea-level; the small bitter lakes on the Isthmus of Suez are cavities of the same kind, as well as the Natron lakes on the Libyan desert west from the delta of the Nile.

## CHAPTER VII.

AFRICA :—TABLE-LAND—CAPE OF GOOD HOPE AND EASTERN COAST—WESTERN COAST—ABYSSINIA—SENEGAMBIA—LOW LANDS AND DESERTS.

THE continent of Africa is 5000 miles long from the Cape of Good Hope to its northern extremity, and as much between Cape Guardafui, on the Indian Ocean, and Cape Verde, on the Atlantic; but, from the irregularity of its figure, it has an area of only 12,000,000 square miles. It is divided in two by the equator, consequently the greater part of it lies under a tropical sun. The high and low lands of this por-



tion of the old continent are so distinctly separated by the Mountains of the Moon, that, with the exception of the mountainous territory of the Atlas, and the small table-land of Barca, it may be said to consist of two parts only, a high country and a low.

An extensive, though not very elevated table-land, occupies all southern Africa, and even reaches to six or seven degrees north of the equator. On three sides it shelves down in tiers of narrow parallel terraces to the ocean, separated by mountain-chains which rise in height as they recede from the coast; and there is reason to believe that the structure of the northern declivity is similar though its extremities only are known—namely, Abyssinia on the east, and the high land of Senegambia on the west; both of which project farther to the north than the central part.

The borders of the table-land are very little known to Europeans, and still less its surface, which no white man has crossed north of the Tropic of Capricorn. A comparatively small part, north from the Cape of Good Hope, has been explored by European travellers. Mr. Truter and Mr. Somerville were the first white men whom the inhabitants of Litakoo had seen. Of an expedition that followed their track, a few years after, no one returned.

North of the Cape the land rises to 6000 feet above the sea, and the Orange River, with its tributaries, may be more aptly said to drain than to irrigate the arid country through which they flow; many of the tributaries, indeed, are only the channels through which the torrents, from the periodical rains, are carried to the Orange River, and are destitute of water many months in the year. The "Dry River," the name of one of these periodical streams, is in that country no misnomer. Their margins are adorned with mimosas, and the sandy plains have furnished treasures to the botanist.

Dr. Smith crossed the tropic of Capricorn in a journey from the Cape of Good Hope, where the country had still the same arid character. North from that there is a great tract unexplored. In 1802 two native travelling merchants crossed the continent, which is 1590 miles wide, from Loanda, on the Atlantic, to Zambeze, on the Mozambique Channel. They found various mercantile nations considerably advanced in civilization, who raise abundance of maize and millet, though the greater part of the country is in a state



of nature. Ridges of low hills, yielding copper, the staple commodity of this country, run from S.E. to N.W. to the west of the dominions of the Cambeze, a country full of rivers, morasses, and extensive salt-marshes, which supply this part of the continent with salt. The travellers crossed 102 rivers, most of them fordable; but the leading feature of this country is Lake N'yassi, of great but unknown length, though comparatively narrow. It begins 200 miles north from the town of Tete, on the Zambeze, and extends from S.E. to N.W., flanked on the east by a range of mountains of the same name, running in the same direction, at the distance of 350 miles from the Mozambique Channel. This is all we know of the table-land of south Africa. It is evident, however, that there can be no very high mountains covered with perpetual snow on the table-land, for, if there were, southern Africa would not be destitute of great rivers; nevertheless, the height of the Komri, or Mountains of the Moon, on its northern edge, must be considerable, to supply the perennial sources of the Nile, the Senegal, and the Niger.

The edges of the table-land are better known. At the Cape of Good Hope the African continent is about 700 miles broad, and ends in three narrow parallel ridges of mountains, the last of which is the highest and abuts on the table-land. All are cleft by precipitous deep ravines, through which winter torrents flow to the ocean. The longitudinal valleys, or karoos, that separate them are tiers, or steps, by which the plateau dips to the maritime plains. The descent is rapid, as both these plains and the mountain-ranges are very narrow. On the western side the mountains form a high group, and end in steep promontories on the coast, where Table Mountain, at Cape Town, 3582 feet high, forms a conspicuous landmark to mariners.

Granite, which is the base of southern Africa, rises to a considerable height in many places, and is generally surmounted by vast horizontal beds of sandstone, which give that character of flatness peculiar to the summits of many of the Cape mountains.

The karoos, or longitudinal valleys, are arid deserts in the dry season, but soon after the rains they are covered with verdure and a splendid flora. The maritime plains partake of the same temporary aridity, though a large portion is rich in cereal productions, vineyards, and pasture.



The most inland of the parallel ranges, about the 20th meridian, is 10,000 feet high, and, though it sinks to some groups of hills at its eastern end, it rises again, about the 27th meridian, in a truly Alpine and continuous chain—the Quotlamba Mountains, which follow the northerly direction of Natal, and are continued in the Lupata range of hills, 80 miles inland, through Zanguebar.

At Natal the coast is grassy, with clumps of trees, like an English park. The Zambeze, and other streams from the table-land, refresh the plains on the Mozambique Channel and Zanguebar, where, though some parts are marshy and covered with mangroves, groves of palm-trees adorn the plains, which yield prodigious quantities of grain, and noble forests cover the mountains; but from 4° N. lat. to Cape Guardafui is a continued desert. There is also a barren tract at the southern end of the Lupata chain, where gold is found in masses and grains on the surface and in the water-courses which tempted the Portuguese to make settlements on these unwholesome coasts.

The island of Madagascar, with its magnificent range of mountains, 12,000 feet high, full of tremendous precipices, and covered with primeval forests, is parallel to the African coast, and only separated from it by the Mozambique Channel; so it may be presumed that it rose from the deep at the same time as the Lupata chain.

The contrast between the eastern and western coasts of South Africa is very great. The escarped bold mountains round the Cape of Good Hope, and its rocky coast, which extends a short way along the Atlantic to the north, are succeeded by ranges of sandstone of small elevation, which separate the internal sandy desert from the equally parched sandy shore. The terraced dip of the Atlantic coast, for 900 miles between the Orange River and Cape Negro, has not a drop of fresh water.

At Cape Negro ranges of mountains, separated by long level tracts, begin, and make a semicircular bend into the interior, leaving plains along the coast 140 miles broad. In Benguela these plains are healthy and cultivated; farther north there are monotonous grassy savannahs, and forests of gigantic trees. The ground in many places, saturated with water, bears a tangled crop of mangroves and tall reeds; which even cover the shoals along that flat coast; hot pes-



tilential vapours hang over them, never dissipated by a breeze.

The country of the Calbongos is the highest land on the coast, where a magnificent group of mountains, 13,000 feet above the sea, covered almost to their tops with large timber, lie not far inland. The low plains of Bafra and Benin, west of them, but especially the delta of the Niger, consist entirely of swamps loaded with rank vegetation. The angel of Death, brooding over these regions in noisome exhalations, guards the interior of that country from the aggressions of the European, and has hitherto baffled his attempts to form settlements on the banks of this magnificent river.

Many portions of North Guinea are so fertile that they might vie with the valley of the Nile in cereal riches, besides various other productions; and though the temperature is very high, the climate is not very unhealthy.

No European has yet seen the Mountains of the Moon, which are said to cross the continent along the northern edge of the great plateau, between two projections or promontories of Abyssinia and Senegambia. This chain divides the semi-civilized states of Soudan, Bornou, and Begharmi from the barbarous nations on the table-land. It extends south of Abyssinia at one end, at the other it joins the high land of Senegambia, and is continued in the Kong range, which runs 1200 miles behind Dahomy and the Gold Coast, and ends in the promontory of Sierra Leone.

The vast Alpine promontory of Abyssinia, or Ethiopia, 700 miles wide, projects from the table-land for 300 miles into the low lands of North Africa. It dips in parallel ridges and longitudinal valleys to the Red Sea on the east, to a low swampy region on the north, and to the plains of Senaar and Kardofan on the west. The whole country is a mass of rugged mountains, torn by ravines, with intervening cultivated valleys and verdant plains. The plain of Dembea, the summit of the plateau, 8000 feet above the sea, the granary of the country, also abounds in pasture, and enjoys a perpetual spring. Dr. Beke, who has travelled to the south of Abyssinia to within six degrees of the equator, found the same natural characters.

The mountains of Abyssinia, and those to the west of it, are the watershed whence the streams that form the Nile flow to the north, while the Quilimane, which rises also in



these mountains, runs to the Indian Ocean, and all the streams that rise east of Bornou run into Lake Tchad.

The geological structure of Abyssinia is similar to that of the Cape of Good Hope, the base being granite, and the superstructure sandstone, occasionally with limestone, schist, and breccia. The granite comes to the surface in the lower parts of Abyssinia, but sandstone predominates in the upper parts, and assumes a tabular form, often lying on the tops of the mountains in enormous flat masses, only accessible by steps cut in the rock, or by ladders. Such insulated spots are used as state prisons. Large tracts are of ancient volcanic rocks, especially in Shoa.

Senegambia, the appendage to the western extremity of the table-land, also projects far into the low lands, and is the watershed whence the streams flow on one side to the plains of Soudan, where they join the Joliba, or Niger; and from the other side, the Gambia, Senegal, and other rivers, run into the Atlantic over a rich cultivated plain, but unhealthy, from the rankness of the vegetation.

The moisture that descends from the northern edge of the table-land of South Africa, under the fiery radiance of a tropical sun, fertilizes a tract of country stretching from sea to sea across the continent, the commencement of the African low lands. A great part of this region, which contains many kingdoms and commercial cities, is a very productive country. The abundance of water, the industry of the natives in irrigating the ground, the periodical rains, and the tropical heat, leave the soil no repose. Agriculture is in a rude state, but nature is so bountiful that rice and millet are raised in sufficient quantity to supply the wants of a numerous population. Gold is found in the river-courses, and there are elephants in the forests; but man is the staple of their commerce,—a disgrace to the savage who sells his fellow-creature, but a far greater disgrace to the more savage purchaser, who dares to assume the sacred name of Christian.

This long belt of never-failing vitality, which has its large lakes, poisonous swamps, deep forests of gigantic trees, and vast solitudes in which no white man ever trode, is of small width compared with its length. In receding from the mountains the moisture becomes less, and the soil gradually worse, sufficing only to produce grass for the flocks of the wandering Beduin. At last a hideous barren waste begins, which



extends northwards 800 miles in unvaried desolation to the grassy steppes at the foot of the Atlas; and, for 1000 miles between the Atlantic and the Red Sea, the nakedness of this blighted land is unbroken but by the valley of the Nile and a few oases.

In the west about 760,000 square miles—an area equal to that of the Mediterranean Sea—is covered by the trackless sands of the Sahara Desert, which is even prolonged for miles into the Atlantic in the form of sandbanks. This desert is alternately scorched by heat and pinched by cold. The wind blows from the east nine months in the year, and at the equinoxes it rushes in a hurricane, driving the sand in clouds before it, producing the darkness of night at midday, and overwhelming caravans of men and animals in common destruction. Then the sand is heaped up in waves ever varying with the blast; even the atmosphere is of sand. The desolation of this dreary waste, boundless to the eye as the ocean, is terrific and sublime; the dry, heated air is like a red vapour, the setting sun seems to be a volcanic fire, and, at times, the burning wind of the desert is the blast of death. There are many salt-lakes to the north, and even the springs are of brine; thick incrustations of dazzling salt cover the ground, and the particles, carried aloft by whirlwinds, flash in the sun like diamonds.

Sand is not the only character of the desert; tracts of gravel and low bare rocks occur at times, not less barren and dreary; but, on the eastern and northern borders of the Sahara, fresh water rises near the surface, and produces an occasional oasis where barrenness and vitality meet. The oases are generally depressed below the level of the desert, with an arenaceous or calcareous border inclosing their emerald verdure like a frame. The smaller oases produce herbage, ferns, acacias, and some shrubs; forests of date-palms grow in the larger, which are the resort of lions, panthers, gazelles, reptiles, and a variety of birds.

In the Nubian and Libyan deserts, to the east of the Sahara, the continent shelves down towards the Mediterranean in a series of steps, consisting of vast level sandy or gravelly deserts, lying east and west, separated by low rocky ridges. This shelving country, which is only 540 feet above the sea at the distance of 750 miles inland, is cut transversely by the Nile, and by a deep furrow parallel to it, in which there is



a long line of oases. This furrow, the Nile, and the Red Sea, nearly parallel to both, are flanked by rocky eminences which go north from the table-land.

On the interminable sands and rocks of these deserts no animal, no insect, breaks the dread silence; not a tree nor a shrub is to be seen in this land without a shadow. In the glare of noon the air quivers with the heat reflected from the red sand, and in the night it is chilled under a clear sky sparkling with its host of stars. Strangely, but beautifully, contrasted with these scorched solitudes, is the narrow valley of the Nile, threading the desert for a thousand miles in emerald green, with its blue waters foaming in rapids among wild rocks, or quietly spreading in a calm stream amidst fields of corn, and the august monuments of past ages.

At the distance of a few days' journey west from the Nile over a hideous flinty plain, lies the furrow already mentioned, tending to the north, and containing the oases of Darfour, Selime, the Great and Little Oases, and the parallel valleys of the Natran lakes, and Bahr-Belama, or the "Dry River." The Great Oasis, or Oasis of Thebes, is 125 miles long, and 4 or 5 broad; the Lesser Oasis, separated from it by 40 miles of desert, is of the same form. Both are rich in verdure and cultivation, with villages amid palm-groves and fruit-trees, mixed with the ruins of remote antiquity; offering scenes of peaceful and soft beauty contrasted with the surrounding gloom. The Natran lakes are in the northern part of the valley of Nitrea, 35 miles west of the Nile; the southern part is a beautiful quiet spot, that became the retreat of Christian monks in the middle of the second century, and at one time contained 360 convents, of which only four remain; from these some very valuable manuscripts of old date have recently been obtained.

Another line of oases runs along the latitude of Cairo, with fresh-water lakes, consequently no less fertile than the preceding. The ruins of the Temple of Jupiter Ammon are in one of them.

Hundreds of miles on the northern edge of the desert, from the Atlantic along the southern foot of the Atlas to the Great Syrte, are pasture-lands without a tree, an ocean of verdure. At the Great Syrte the Sahara comes to the shores of the Mediterranean, and, indeed, for 1100 miles between the termination of the Atlas and the little table-land of Barca, the



ground is so unprofitable that the population only amounts to about 30,000, and these are mostly wandering tribes who feed their flocks on the grassy steppes. Magnificent countries lie along the Mediterranean coast, north of the Atlas, susceptible of cultivation. History, and the ruins of many great cities, attest their former splendour. Even now there are many populous commercial cities, and much grain is raised, though a great part of these valuable kingdoms is badly cultivated, or not cultivated at all.

The base of the sandy parts of North Africa is stiff clay. In Lower Nubia, between the parallels of Assouan and Esneh, red and white granite prevail, followed by argillaceous sandstone. Middle Egypt is calcareous, and lower down the Nile sand and alluvium cover the surface.

The prodigious extent of desert is one of the most extraordinary circumstances in the structure of the old continent. A zone of almost irretrievable desolation prevails from the Atlantic Ocean, across Africa and through Central Asia, almost to the Pacific Ocean, through at least 120 degrees of longitude. There are also many large districts of the same sterile nature in Europe; and if to these sandy plains the deserts of Siberia be added, together with all the barren and rocky mountain tracts, the unproductive land in the Old World is prodigious. The quantity of salt on the sandy plains is enormous, and proves that they have been part of the bed of the ocean, or of inland seas, at no very remote geological period. The low lands round the Black Sea and Caspian, and the Lake of Aral, seem to have been the most recently reclaimed, from the great proportion of shells in them identical with those now existing in these seas. The same may be said of the Sahara Desert, where salt and recent shells are plentiful.

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## CHAPTER VIII.

AMERICAN CONTINENT—THE MOUNTAINS OF SOUTH AMERICA—  
THE ANDES—THE MOUNTAINS OF THE PARIMA AND BRAZIL.

SOME thinner portion of the crust of the globe under the meridians that traverse the continent of America from Cape Horn



to the Arctic Ocean must have yielded to the expansive forces of the subterranean fires, or been rent by the contraction of the strata in cooling. Through this the Andes had arisen, producing the greatest influence on the form of the continent, and the peculiar simplicity that prevails in its principal mountain systems, which, with very few exceptions, have a general tendency from north to south. The continent is 9000 miles long, and, its form being two great peninsulas joined by a long narrow isthmus, it is divided by nature into the three parts of South, Central, and North America; yet these three are connected by the mighty chain of the Andes, but little inferior in height to the Himalaya, running along the coast of the Pacific from within the Arctic nearly to the Antarctic circle. In this course every variety of climate is to be met with, from the rigour of polar congelation to the scorching heat of the torrid zone; while the mountains are so high that the same extremes of heat and cold may be experienced in the journey of a few hours from the burning plains of Peru to the snow-clad peaks above. In this long chain there are three distinct varieties of character, nearly, though not entirely, corresponding to the three natural divisions of the continent. The Andes of South America differ materially from those of Central America and Mexico, while both are dissimilar to the Andes of North America, generally known as the Chippewayan or Rocky Mountains.

The greatest length of South America from Cape Horn to the Isthmus of Panama is about 4550 miles. It is very narrow at its southern extremity, but increases in width northward to the latitude of Cape Roque on the Atlantic, between which and Cape Blanco on the Pacific it attains its greatest breadth of nearly 2446 miles. It consists of three mountain systems, separated by the basins of three of the greatest rivers in the world. The Andes run along the western coast from Cape Horn to the Isthmus of Panama, in a single chain of small width but majestic height, dipping rapidly to the narrow maritime plains of the Pacific, but descending on the east in high valleys and occasional offsets to plains of vast extent, whose dead level is for hundreds of miles as unbroken as that of the ocean by which they are bounded. Nevertheless two detached mountain systems rise on these plains, one in Brazil between the Rio de la Plata and the river of the Amazons; the other is that of



Parima and Guiana, lying between the river of the Amazons and the Orinoco.

The great chain of the Andes first raises its crest above the waves of the Antarctic Ocean in the majestic dark mass of Cape Horn, the southernmost point of the archipelago of Terra del Fuego. This group of mountainous islands, equal in size to Britain, is cut off from the main land by the Strait of Magellan. The islands are penetrated in every direction by bays and narrow inlets of the sea, or fiords, ending in glaciers fed by the snow on the summits of mountains 6000 feet high. Peat-mosses cover the higher declivities of these mountains, and their flanks are beset with densely entangled forests of brown beech, which never lose their dusky leaves, producing altogether a savage dismal scene. The mountains which occupy the western side of this cluster of islands sink down to wide level plains to the east, like the continent itself, of which the archipelago is but the southern extremity.

The Pacific comes to the very base of the Patagonian Andes for about 1000 miles, from Cape Horn to the 40th parallel of south latitude. The whole coast is lined by a succession of archipelagos and islands, separated from the iron-bound shores by narrow arms of the sea, which, in the more southern part, are in fact profound longitudinal valleys of the Andes filled by the ocean, so that the chain of islands running parallel to the axes of the mountains is but the tops of an exterior range rising above the sea.

The coast itself for 650 miles is begirt by walls of rock, which sink into an unfathomable depth, torn by long crevices or fiords, similar to those on the Norwegian shore, ending in tremendous glaciers, whose masses, falling with a crash like thunder, drive the sea in sweeping breakers through these chasms. The islands and the main land are thickly clothed with forests, which are of a less sombre aspect as the latitude decreases.

South of the archipelago of Chiloe there are few spots susceptible of cultivation, and none fit for the permanent habitation of man; but Chiloe itself, the most southerly part of the globe that is inhabited, is fertile. There are four magnificent volcanoes in the Andes opposite to these islands. In southern Chili the Andes retire a little from the sea, leaving plains traversed by ranges of hills 2000 or 3000



feet high, running parallel to the coast, cut by valleys and separated by flat basins, the beds of ancient lakes, now inhabited.

The Cordillera itself runs behind in a single chain, about 20 miles broad, with 12,000 feet of mean elevation. The mountain-tops maintain a horizontal line parallel to that of perpetual snow, surmounted at long intervals by groups of points, or a solitary volcanic cone, in delicate relief on the clear blue sky. Of these, Descabezado, the "Beheaded," rises 12,102 feet above the sea, and behind Valparaiso, in the centre of a knot of mountains, the magnificent volcano of Aconcagua has an absolute height of 23,000 feet. All the higher ranges of the Chilian Andes are uninhabitable; there are very few valleys which lead to the central range, and these are mostly in southern Chili; in other places the chain is utterly impassable to beasts of burthen. The flat parts of these mountains are often volcanic, and the precipices are frightful. The descent is so abrupt on both sides, that northern Chili may be esteemed a declivity of the Cordillera.

About the latitude of Concepcion the dense forests of semi-tropical vegetation cease with the humid equable climate; and as no rain falls in central Chili for nine months in the year, the brown, purple, and tile-red hills and mountains are only dotted here and there with low trees and bushes; very soon, however, after the heavy showers have moistened the cracked ground, it is covered with a beautiful but transient flora. In some valleys it is more permanent and of a tropical character, mixed with Alpine plants. In southern Chili rain falls only once in two or three years, the consequence of which is sterility on the western precipitous and unbroken descent of the Andes; but on the east various secondary branches leave the central Cordillera, which extend 300 or 400 miles into the plains, wooded to a great height.

The chain takes the name of the Peruvian Andes about the 24th degree of south latitude, and is separated from the Pacific for 1250 miles by a sandy desert, seldom above 60 miles broad, on which a drop of rain never falls, where bare rocks pierce through the moving sand, and which has a mine of rock-salt, a character of deserts generally. The width of the coast is nearly the same to the Isthmus of



Panama, but damp luxuriant forests, full of orchideæ, begin about the latitude of Payta, and continue northwards.

From its southern extremity to the Nevada of Chorolque, in  $21^{\circ} 30'$  S. lat., the Andes are merely a grand range of mountains, but north of that the chain becomes a very elevated narrow table-land, or longitudinal Alpine valley, in the direction of the coast, bounded on each side by a parallel row of high mountains, rising much above the table-land. These parallel Cordilleras are united at various points by enormous transverse groups or mountain-knots, or by single ranges crossing between them like dykes, a structure that prevails to Pasto in  $1^{\circ} 13' 6''$  S. lat. The descent to the Pacific is very steep, but the dip is less rapid to the east, whence offsets diverge to the level plains. The most remarkable peculiarity of the Andes is the absence of transverse valleys; with the exception of a few in the Patagonian and south Chilean Andes there is not an opening through these mountains in the remainder of their course to the Isthmus of Panama.

Unlike the table-lands of Asia of the same elevation, where cultivation is confined to the more sheltered spots, or those still lower in Europe, which are only fit for pasture, these lofty regions of the Andes yield exuberant crops of every European grain, and have many populous cities enjoying the luxuries of life, with universities, libraries, civil and religious establishments, at altitudes equal to that of the Peak of Teneriffe, which is 12,358 feet above the sea level. Villages are placed and mines are wrought at heights little less than the top of Mont Blanc. This state is not limited to the present times, since these table-lands were made the centre of civilization by a race of mankind which "bear the same relation to the Incas and the present inhabitants that the Etruscans bear to the ancient Romans and to the Italians of our own days."

The table-land of Desaguadero, one of the most remarkable of these, has an absolute altitude of 13,000 feet, and a breadth varying from 30 to 60 miles: it stretches 500 miles along the top of the Andes, between the transverse mountain-group of Las Lipez, in  $20^{\circ}$  S. lat., and the enormous mountain-knot of Vilcanata and Cusco, which, extending from east to west, shuts in the valley on the north, occupying an area three times as large as Switzerland, and rising 8300



feet above the surface of the table-land, from which some idea may be formed of the gigantic scale of the Andes. This table-land or valley is bounded on each side by the two grand chains of the Bolivian Andes: that on the west is the Cordillera of the coast; the range on the east side is the Cordillera Reale. These two rows of mountains lie so near the edge that the whole breadth of the table-land, including both, is only 300 miles. All the snowy peaks of the Cordilleras of the coast, varying from 18,000 to 22,000 feet in absolute height, are either active volcanoes or of volcanic origin, and, with the exception of the volcano of Uvinas, they are all situate upon the maritime declivity of the table-land, and not more than 60 miles from the Pacific; consequently the descent is very abrupt. The eastern Cordillera, which begins at the metalliferous mountains of Pasco and Potosi, is not more than 17,000 feet high to the south, and below the level of perpetual snow, but its northern portion contains the three peaked mountains of Sorata, 25,000 feet above the sea, and is one of the most magnificent chains in the Andes. The snowy part begins with the gigantic mass of Illimani, whose serrated ridges, elongated in the direction of the axis of the Andes, rise 24,000 feet above the ocean. The lowest glacier on its southern slope does not come below 16,500 feet, and the valley of Totoral, a mere gulf 18,000 feet deep, in which Vesuvius might stand, comes between Illimani and the Nevada of Tres Cruces, from whence the Cordillera Reale runs northward in a continuous line of snow-clad peaks to the group of Vilcanata and Cusco, which unites it with the Cordilleras of the coast.

The valley or table-land of Desaguadero, occupying 150,000 square miles, has a considerable variety of surface; in the south, throughout the mining district, it is poor and cold. There Potosi, the highest city in the world, stands, at an absolute elevation of 13,350 feet, on the declivity of a mountain celebrated for its silver-mines at the height of 16,060 feet. Chiquisaca, the capital of Bolivia, containing 13,000 inhabitants, lies to the south-east of Potosi, in the midst of cultivated fields. The northern part of the valley is populous, and productive in wheat, maize, and other grain; and there is the Lake of Titicaca, twenty times as large as the Lake of Geneva. The islands and shores of this lake still exhibit ruins of gigantic magnitude, monuments



of a people more ancient than the Incas. The modern city of La Paz d' Ayachuco with 40,000 inhabitants, on its southern border, stands in the most sublime situation that can be imagined, having the vast Nevada of Illimani to the north, and the no less magnificent Sorata to the south. The two ranges of the Bolivian Andes in such close approximation, with their smoking cones and serrated ridges, form one of the most august scenes in nature.

Many offsets leave the eastern side of the Cordillera Reale, which terminate in the great plain of Chiquitos and Paraguay; the most important is the Sierra Nevada de Cochobamba, which bounds a rich valley of the same name on the north, and, after dividing the basins of the Rio de la Plata from that of the Amazons for 200 miles, ends near the town of Santa Cruz de la Sierra.

There are fertile valleys and plains in the snow-capped group of Vilcanata and Cusco. The city of Cusco, which contains nearly 50,000 inhabitants, was the capital of the empire of the Incas, and the ruins of the Temple of the Sun still bear marks of its former splendour. Two ancient Peruvian roads lead from Cusco to Quito, in no respect inferior to the old Roman roads: that over the mountain plains is higher than the Peak of Teneriffe. North from Cusco lies the plain of Bombon, which assumes the bleak and dismal character common to the mining districts. It is 14,000 feet above the sea, and only 18 miles wide between the Cordilleras that bound its sides, and which send their streams into the Lake of Lauri or Laurichoco, the source of the river of the Amazons. There are many small lakes on the table-lands and high valleys of the Andes, some even within the range of perpetual snow. They are very cold and unfathomably deep, often of the purest sea-green colour, probably the craters of old volcanoes.

The crest of the Andes is split into three rows of mountains running from south to north from the transverse group of Pasco and Huanuco, which shuts in the valley of Bombon between the 11th and 10th parallels of south latitude: that in the centre separates the wide fertile valley of the upper Maranon from the still richer valley of Huallago. The western chain alone reaches the line of perpetual snow, and no mountain north of this for 400 miles to Chimborazo arrives at the snow-line.



North from the group of Loxas, celebrated for its forests of the cinchona or Peruvian bark tree, the summit of the Andes spreads into a narrow table-land, which extends 350 miles in the direction of the chain, passing through the republic of the Equator to the mountain-group of Pastos in New Grenada. It is hemmed in on each side by Cordilleras of gigantic size, and divided by the cross ridges of the Paramo del Assuay and Chisinche into three parts, namely, the plains of Cuença, Tassia, and Quito, by much the greatest. The plain of Cuença is uninteresting, but the plain of Tassia is very magnificent; the huge dome-shaped Chimborazo rises in its eastern Cordillera 21,428 feet above the sea, yet not the highest mountain in the Andes; and in the same Cordillera are the pyramidal peaks of Illiniza, the wreck of an ancient volcano. The height of Illiniza above the Pacific and above the table-land was measured by the French Academicians, and from their measurement they obtained the height of Quito, and an approximate value of the barometrical coefficient. In the western Cordillera lies the ever-agitated volcano of Sangay, together with Cotopaxi, the most beautiful of volcanoes, whose cone of dazzling white is six times as high as that of the Peak of Teneriffe.

The table-land of Quito, one of the largest and finest in the Andes, is 200 miles long and 30 wide, with an absolute altitude of 10,000 feet, bounded by the most magnificent series of volcanoes and mountains in the New World. A peculiar interest is attached to two of the many magnificent volcanoes in the parallel Cordilleras that flank it on each side. In the eastern chain the beautiful snow-clad cone of Cayambe is traversed by the equator, the most remarkable division of the globe; and in the western Cordillera the cross still stands on the summit of Pinchincha, 15,924 feet above the Pacific, which served for a signal to Messieurs Bouguer and Condamine in the measurement of a degree of the meridian.

Some parts of the plain of Quito to the south are sterile, but the soil generally is good, and perpetual spring clothes it with exuberant vegetation. The city of Quito, containing 70,000 inhabitants, on the side of Pinchincha, has an absolute height of 9000 feet. The city is well built and handsome; the churches are splendid; it possesses universities, the comforts and luxuries of civilized life, in a situation of unri-



valled grandeur and beauty. Thus on the very summit of the Andes there is a world by itself, with its mountains and its valleys, its lakes and rivers, populous towns and cultivated fields. Many monuments of the Incas are still found in good preservation in these plains, where the scenery is magnificent; eleven volcanoes are visible from one spot. Although the Andes are inferior in height to the Himalaya, yet the domes of trachyte, the truncated cones of the active volcanoes, and the serrated ruins of those that are extinct, mixed with the bald features of primary mountains, give an infinitely greater variety to the scene, while the smoke, and very often the flame, issuing from these regions of perpetual snow, increase its sublimity. Stupendous as these mountains appear even from the plains of the table-land, they are merely the inequalities of the tops of the Andes, the serrated summit of that mighty chain.

Between the large group of Los Pastos, containing several active volcanoes, and the group of Los Papos in the second degree of north latitude, the table-land is only 6900 feet above the sea; and north of the latter mountain-knot the crest of the Andes splits into three Cordilleras, which meet no more. The most westerly of these, the continuation of the great chain, divides the valley of the river Cauca from the Gulf of Panama; it is only 5000 feet high, and the lowest of the three. Though but 20 miles broad, it is so steep, and so difficult to pass, that travellers cannot go on mules, but are carried on men's shoulders; it is exceedingly rich in gold and platina. The central branch, or Cordillera of Quindici, runs due north between the Magdalena and Cauca, with a mean height of 10,000 feet, though rising to 18,314 feet on the Peak of Tolima. The most easterly of the three Cordilleras, called the Sierra de la Summa Paz, spreads out into the table-land of Sante Fé de Bogota, Tunja, and others, which have an elevation of about 9000 feet, and its precipices border the rivers Orinoco and Meta. The tremendous crevice of Icononza occurs in the path leading from the city of Sante Fé de Bogota to the banks of the Magdalena. It probably was formed by an earthquake, and is like an empty mineral vein, across which are two natural bridges; the lowest is composed of stones that have been jammed between the rocks in their fall. This Cordillera comprises the Andes of Cundinamarca and Merida, and



goes north-east through Grenada to the 10th northern parallel, where it joins the coast-chain of Venezuela or Caraccas, which runs due east, and ends at Cape Paria in the Caribbean Sea, or rather at the eastern extremity of the island of Trinidad. This coast-chain is so majestic and beautiful that Baron Humboldt says it is like the Alps rising out of the sea without their snow. The insulated group of Santa Martha, 19,000 feet high, deeply covered with snow, stands on an extensive plain between the delta of the Magdalena and the sea-lake of Maracaybo, and is a landmark to mariners far off in the Caribbean Sea.

The passes over the Chilian Andes are numerous; that of Portilla, leading from St. Jago to Mendoza, is the highest; it crosses two ridges; the most elevated is 14,365 feet above the sea, and vegetation ceases far below its summit. Those in Peru are higher, though none reach the snow-line. In Bolivia the mean elevation of the passes in the western and eastern Cordilleras is 14,892 and 14,422 feet respectively: the peaks in the eastern Cordillera are the highest, but the passes in the western are on the most elevated part of the range, while those in the eastern are on the lowest. That leading from Sorata to the auriferous valley of Tipuani is perhaps the highest in Bolivia. From the total absence of vegetation and the intense cold it is supposed to be 16,000 feet above the Pacific; those to the north are but little lower. The pass of Quindiu in Colombia, though only 11,500 feet high, is the most difficult of all across the Andes: but those crossing the mountain-knots from one table-land to another are the most dangerous; for example, that over the Paramo del Assuay, in the plain of Quito, where the road is nearly as high as Mont Blanc, and travellers not unfrequently perish from cold winds in attempting it.

On the western side of the Andes little or no rain falls, except at their most southern extremity, and scanty vegetation appears only in spots, or in small valleys. Excessive heat and moisture combine to cover the eastern side and its offsets with tangled forests of large trees and dense brushwood. This exuberance diminishes as the height increases, till at last the barren rocks are covered only by snow and glaciers. Nothing can surpass the desolation of these elevated regions, where nature has been shaken by terrific convulsions. The dazzling snow fatigues the eye; the huge



masses of bald rock, the mural precipices, and the chasms yawning into dark unknown depths, strike the imagination; while the crash of the avalanche, or the rolling thunder of the volcano, startles the ear. In the dead of night, when the sky is clear and the wind hushed, the hollow moaning of the volcanic fire fills the Indian with superstitious dread in the deathlike stillness of these solitudes.

In the very elevated plains in the transverse groups, such as that of Bombon, however pure the sky, the landscape is lurid and colourless; the dark blue shadows are sharply defined, and from the thinness of the air it is hardly possible to make a just estimate of distance. Changes of weather are sudden and violent; clouds of black vapour arise, and are carried by fierce winds over the barren plains; snow and hail are driven with irresistible impetuosity; and thunderstorms come on, loud and awful, without warning. Notwithstanding the thinness of the air, the crash of the peals is quite appalling, while the lightning runs along the scorched grass, and sometimes, issuing from the ground, destroys a team of mules or a flock of sheep at one flash.\*

Currents of warm air are occasionally met with on the crest of the Andes—an extraordinary phenomenon in such gelid heights, which is not yet accounted for: they generally occur two hours after sunset, are local and narrow, not exceeding a few fathoms in width; similar to the equally partial blasts of hot air in the Alps. A singular instance, probably of earth-light, occurs in crossing the Andes from Chili to Mendoza: on this rocky scene a peculiar brightness occasionally rests, a kind of indescribable reddish light, which vanishes during the winter rains, and is not perceptible on sunny days. Dr. Pœppig ascribes the phenomenon to the dryness of the air; he was confirmed in his opinion from afterwards observing a similar brightness on the coast of Peru, and it has also been seen in Egypt.

The Andes descend to the eastern plains by a series of cultivated levels, as those of Tucuman, Salta, and Jujuy, in the republic of La Plata, with many others. That of Tucuman is 3600 feet above the sea, the garden of the republic.

The low lands to the east of the Andes are divided by the table-lands and mountains of Parima and Brazil into

\* Dr. Pœppig's 'Travels in South America.'



three parts, of very different aspect—the deserts and pampas of Patagonia and Buenos Ayres; the *Silvas*, or woody basin of the Amazons; and the *Llanos*, or grassy steppes of the Orinoco. The eastern table-lands nowhere exceed 2500 feet of absolute height; and the plains are so low and flat, especially at the foot of the Andes, that a rise of 1000 feet in the Atlantic Ocean would submerge more than half the continent of South America.

The system of the Parima is a group of mountains scattered over a table-land not more than 2000 feet above the sea, which extends 600 or 700 miles from east to west, between the river Orinoco, the Rio Negro, the Amazons, and the Atlantic Ocean. It is quite unconnected with the Andes, being 80 leagues east from the mountains of New Grenada. It begins 60 or 70 miles from the coast of Venezuela, and ascends by four successive terraces to undulating plains which come within one or two degrees of the equator, and is twice as long as it is broad.

Seven chains, besides groups of mountains, cross the table-land from west to east, of which the chief is the Sierra del Parima. Beginning at the mouth of the Meta, it crosses the plains of Esmeralda to the borders of Brazil, whence, under the name of the Sierra Pacaraime, it goes to the left bank of the Rupuniri, a tributary of the Essequibo; then, bending to the south, it runs in a tortuous line between Brazil and Guiana to the Atlantic. This chain, not more than 600 feet high, is everywhere escarped, and forms the watershed between the tributaries of the Amazons and those of the Orinoco, the Essequibo, and the rivers of Guiana. The Orinoco rises on the northern side of the Sierra del Parima, and in its circuitous course over the plains of Esmeralda it breaks through the western extremity of that chain in two places, 12 leagues asunder, where it dashes with violence against the transverse shelving rocks and dykes, forming the splendid series of rapids and cataracts of Maypures and Atures, from whence the Parima Mountains have got the name of the Cordillera of the cataracts of the Orinoco. The chain is of granite, which forms the banks and fills the bed of the river, covered with luxuriant tropical vegetation, especially palm-forests. In the district of the Upper Orinoco, near Chari-chana, there is a granite rock which emits musical sounds at sunrise, like the notes of an organ, occasioned by the dif-



ference of temperature of the external air and that which fills the deep narrow crevices with which the rock is everywhere torn. Something of the same kind occurs at Mount Sinai.

The other parallel chains that extend over the table-land in Venezuela and Guiana are separated by flat savannahs, generally barren in the dry season, but after the rains covered with a carpet of emerald-green grass, often six feet high, mixed with flowers. The vegetation in these countries is splendid beyond imagination: the regions of the Upper Orinoco and Rio Negro, and of almost all the mountains and banks of rivers in Guiana, are clothed with majestic and impenetrable forests, whose moist and hot recesses are the abode of the singular and beautiful race of the Orchideæ and tangled creepers of many kinds.

Although all the mountains of the system of Parima are wild and rugged, they are not high; the inaccessible peak of the Cerro Duida, which rises insulated 7155 feet above the plain of Esmeralda, is the culminating point, and the highest mountain in South America east of the Andes.

The fine savannahs of the Rupununi were the country of romance in the days of Queen Elizabeth. South of the Pacaraima, near an inlet of the river, the far-famed city of Manoa was supposed to stand, the object of the unfortunate expedition of Sir Walter Raleigh; about 11 miles south-west of which is situated the Lake Amucu, "the Great Lake with golden banks,"—great only during the periodical floods.

On the southern side of the basin of the river Amazons lies the table-land of Brazil, nowhere more than 2500 feet high, which occupies half of that empire, together with part of the Argentine Republic and Uruguay Orientale. Its form is a triangle, whose apex is at the confluence of the rivers Marmora and Beni, and its base extends, near the shore of the Atlantic, from the mouth of the Rio de la Plata to within three degrees of the equator. It is difficult to define the limits of this vast territory, but some idea may be formed of it by following the direction of the rapids and cataracts of the rivers descending from it to the plains around. Thus a line drawn from the fall of the river Tocantines, in  $3^{\circ} 30'$  S. lat., to the cataracts of the Madiera, in the eighth degree of south latitude, will nearly mark its northern boundary: from thence the line would run S.W. to the junction of the



Marmora and Beni ; then, turning to the S.E. along the Serro dos Paricis, it would proceed south to the cataract of the Paranà, called the Sete Quedas, in  $24^{\circ} 30'$  S. lat. ; and lastly, from thence, by the great falls of the river Iguassu, to the Morro de Santa Martha, at the mouth of the Rio de la Plata.

Chains of mountains, nearly parallel, extend from south-west to north-east, 700 miles along the base of the triangle, with a breadth of about 400 miles. Of these the Sierra do Mar, or the "coast-chain," reaches from the river Uruguay to Cape San Roque, never more distant than 20 miles from the Atlantic, except to the south of the bay of Santos, where it is 80. Offsets diverge to the right and left: the granite peak of Corcovado, in the bay of Rio de Janeiro, 2306 feet high, is the end of one. The parallel chain of Espinhaço, beginning near the town of San Paolo, and forming the western boundary of the basin of the Rio San Francisco, is the highest in Brazil, one of its mountains being 8426 feet above the sea. All the mountains in Brazil have a general tendency from S.W. to N.E., except the transverse chain of Sierra das Vertentes, which begins 60 miles south of Villa Rica, and runs in a tortuous line to its termination near the junction of the Marmora and Beni, in  $11^{\circ}$  S. lat. It forms the watershed of the tributaries of the San Francesco and Amazons on the north, and those of the Rio de la Plata on the south; its greatest height is 3500 feet above the sea, but its western part, the Sierra Paricis, is merely a succession of detached hills. This chain, the coast-chain of Venezuela and the mountains of Parima, are the only ranges on the continent of America that do not entirely, or in some degree, lie in the direction of the meridians.

Magnificent forests of tall trees, bound together by tangled creeping and parasitical plants, clothe the declivities of the mountains, and line the borders of the Brazilian rivers, where the soil is rich and the verdure brilliant. Many of the plains on the table-land bear a coarse nutritious grass after the rains only; but vast undulating tracts are always verdant with excellent pasture, intermixed with fields of corn: some parts are bare sand and rolled quartz; and the Campas Paricis, north of the Sierra Vestentes, in Matto Grasso, is a sandy desert of unknown extent, similar to the Great Gobi on the table-land of Tibet.



## CHAPTER IX.

THE LOW LANDS OF SOUTH AMERICA—DESERT OF PATAGONIA  
—THE PAMPAS OF BUENOS AYRES—THE SILVAS OF THE  
AMAZONS—THE LLANOS OF THE ORINOCO AND VENEZUELA  
—GEOLOGICAL NOTICE.

THE southern plains are the most barren of the three great tracts of American low lands; they stretch from Terra del Fuego over 27 degrees of latitude, or 1900 miles, nearly to Tucuman and the mountains of Brazil. Palms grow at one end, deep snow covers the other many months in the year. This enormous plain, of 1,620,000 square miles, begins on the eastern part of Terra del Fuego, which is a flat covered with trees, and therefore superior to its continuation on the continent through eastern Patagonia, which, for 800 miles from the land's end to beyond the Rio Colorado, is a desert of shingle. It is occasionally diversified by huge boulders, tufts of brown grass, low bushes armed with spines, brine lakes, incrustations of salt white as snow, and by black basaltic platforms, like plains of iron, at the foot of the Andes, barren as the rest. Eastern Patagonia, however, is not one universal flat, but a succession of shingly horizontal plains at higher and higher levels, separated by long lines of cliffs or escarpments, the gable ends of the tiers or plains. The ascent is small, for even at the foot of the Andes the highest of these platforms is only 3000 feet above the ocean. The plains are here and there intersected by a ravine or a stream, the waters of which do not fertilize the blighted soil. The transition from intense heat to intense cold is rapid, and piercing winds often rush in hurricanes over these deserts, shunned even by the Indian, except when he crosses them to visit the tombs of his fathers. The shingle ends a few miles to the north of the Rio Colorado: there the red calcareous earth of the Pampas begins, monotonously covered with coarse tufted grass without a tree or bush. This country, nearly as level as the sea, and without a stone, extends almost to the table-land of Brazil, and for 1000 miles be-



tween the Atlantic and the Andes, interrupted only at vast distances by a solitary umbú, the only tree of this soil, rising like a great landmark. This wide space, though almost destitute of water, is not all of the same description. In the Pampas of Buenos Ayres there are four distinct regions. For 180 miles west from Buenos Ayres they are covered with thistles and lucern of the most vivid green so long as the moisture from the rain lasts. In spring the verdure fades, and a month afterwards the thistles shoot up 10 feet high, so dense and so protected by spines that they are impenetrable. During summer the dried stalks are broken by the wind, and the lucern again spreads freshness over the ground. The Pampas for 430 miles west of this region is a thicket of long tufted luxuriant grass, intermixed with gaudy flowers, affording inexhaustible pasture to thousands of horses and cattle; this is followed by a tract of swamps and bogs, to which succeeds a region of ravines and stones, and, lastly, a zone, reaching to the Andes, of thorny bushes and dwarf trees in one dense thicket. The flat plains in Entre Rios in Uruguay, those of Santa Fé, and a great part of Cordova and Tucuman, are of sward, with cattle farms. The banks of the Paraná, and other tributaries of the La Plata, are adorned with an infinite variety of tropical productions, especially the graceful tribe of palms; and the river islands are bright with orange-groves. A desert of sand, called Il Gran Chaco, exists west of the Paraguay, the vegetable produce of which is confined to varieties of the aloe and cactus tribes, the last the food of the cochineal insect, which forms a valuable article of commerce. Adjoining this desert are the unknown regions of the Chiquitos and Moxos, covered with forests and jungle.

The Pampas of Buenos Ayres, 1000 feet above the sea, sinks to its level along the foot of the Andes, where the streams from the mountains collect in large lakes, swamps, lagoons of prodigious size, and wide-spreading salines. The swamp or lagoon of Ybera, of 1000 square miles, is entirely covered with aquatic plants. These swamps are swollen to thousands of square miles by the annual floods of the rivers, which almost inundate the Pampas, leaving a fertilizing coat of mud. Multitudes of animals perish in the floods, and the drought that sometimes succeeds is more fatal. Between the years 1830 and 1832 two millions of cattle died from



want of food. Millions of animals are sometimes destroyed by casual and dreadful conflagrations in these countries, when covered with dry grass and thistles.

The Silvas of the river of the Amazons, lying in the centre of the continent, form the second division of the South American low lands. This country is more uneven than the Pampas, and the vegetation is so dense that it can only be penetrated by sailing up the river or its tributaries. The forests not only cover the basin of the Amazons, but also its limiting mountain-chains, the Sierra Vertentes and Parima; so that the whole forms an area of woodland more than six times the size of France, lying between the eighteenth parallel of south latitude and the seventh of north; consequently intertropical and traversed by the equator. There are some marshy savannahs between the third and fourth degrees of north latitude, and some grassy steppes south of the Pacaraim chain; but they are insignificant compared with the Silvas, which extend 1500 miles along the river, varying in breadth from 350 to 800 miles, and probably more. According to Baron Humboldt, the soil, enriched for ages by the spoils of the forest, consists of the richest mould. The heat is suffocating in the deep and dark recesses of these primeval woods, where not a breath of air penetrates, and where, after being drenched by the periodical rains, the damp is so excessive that a blue mist rises in the early morning among the huge stems of the trees, and envelops the entangled creepers stretching from bough to bough. A deathlike stillness prevails from sunrise to sunset; then the thousands of animals that inhabit these forests join in one loud discordant roar, not continuous, but in bursts. The beasts seem to be periodically and unanimously roused, by some unknown impulse, till the forest rings in universal uproar. Profound silence prevails at midnight, which is broken at the dawn of morning by another general roar of the wild chorus. Nightingales, too, have their fits of silence and song: after a pause, they

“—— all burst forth in choral minstrelsy,  
As if some sudden gale had swept at once  
A hundred airy harps.”\*

The whole forest often resounds, when the animals, startled

\* Wordsworth.



from their sleep, scream in terror at the noise made by bands of its inhabitants flying from some night-prowling foe. Their anxiety and terror before a thunder-storm is excessive, and all nature seems to partake in the dread. The tops of the lofty trees rustle ominously, though not a breath of air agitates them; a hollow whistling in the high regions of the atmosphere comes as a warning from the black floating vapour; midnight darkness envelops the ancient forests, which soon after groan and creak with the blast of the hurricane. The gloom is rendered still more hideous by the vivid lightning and the stunning crash of thunder. Even fishes are affected with the general consternation; for in a few minutes the Amazons rages in waves like a stormy sea.

The Llanos of the Orinoco and Venezuela, covered with long grass, form the third department of South American low lands, and occupy 153,000 square miles between the deltas of the Orinoco and the river Coqueta, flat as the surface of the sea; frequently there is not an eminence a foot high in 270 square miles. They are twice as long as they are broad; and, as the wind blows constantly from the east, the climate is the more ardent the farther west. These steppes for the most part are destitute of trees or bushes, yet in some places they are dotted with the mauritia and other palm-trees. Flat as these plains are, there are in some places two kinds of inequalities: one consists of banks or shoals of grit or compact limestone, five or six feet high, perfectly level for several leagues, and imperceptible except on their edges; the other inequality can only be detected by the barometer or levelling instruments; it is called a Mesa, and is an eminence rising imperceptibly to the height of some fathoms. Small as the elevation is, a mesa forms the watershed, from S.W. to N.E., between the affluents of the Orinoco and the streams flowing to the northern coast of Terra Firma. In the wet season, from April to the end of October, the tropical rains pour down in torrents, and hundreds of square miles of the Llanos are inundated by the floods of the rivers. The water is sometimes 12 feet deep in the hollows, in which so many horses and other animals perish that the ground smells of musk, an odour peculiar to many South American quadrupeds. From the flatness of the country, too, the waters of some affluents of the Orinoco are driven backwards by the floods of that river, especially when aided



by the wind, and form temporary lakes. When the waters subside these steppes, manured by the sediment, are mantled with verdure, and produce ananas with occasional groups of palm-trees, and mimosas skirt the rivers. When the dry weather returns, the grass is burnt to powder, the air is filled with dust raised by currents occasioned by difference of temperature, even where there is no wind. If by any accident a spark of fire falls on the scorched plains, a conflagration spreads from river to river, destroying every animal, and leaves the clayey soil sterile for years, till vicissitudes of weather crumble the brick-like surface into earth.

The Llanos lie between the equator and the Tropic of Cancer; consequently the mean annual temperature is about  $84^{\circ}$  of Fahrenheit. The heat is most intense during the rainy season, when tremendous thunder-storms are of common occurrence.

## GEOLOGY OF SOUTH AMERICA.

THE most remarkable circumstance in the geological arrangement of South America is the vast but partial development of volcanic force, which is confined to the chain of the Andes, and even in some parts only to the western Cordillera, while not a trace of it is to be found either on the great plains to the east, or on the table-lands which divide them. The actual vents occur in linear groups. The most southern of these extends from Yntales in Patagonia to the volcanoes of central Chili, a distance of 800 miles: the second volcanic line, occupying 600 miles of latitude, lies between Araquipo and Patas:\* the third extends over 300 miles between Riobamba and Popayan. That these groups of active volcanoes are connected there can be little doubt, as they are only separated by a few hundred miles; and thus there is a line of volcanic action, 1700 miles long, entirely confined to the Andes, to which the volcanic islands of Juan Fernandez and the Galapagos form a parallel line.

Granite, which seems to be the base of the whole continent, is widely spread to the east and south: it appears in

\* Mr. Darwin.



Terra del Fuego and in the Patagonian Andes abundantly and at great elevations; but it comes into view so rarely in the other parts of the chain that Baron Humboldt says a person might travel years in the Andes of Peru and Quito without falling in with it: he never saw it at a greater height above the sea than 11,500 feet. Gneiss is here and there associated with the granite, but mica-schist is by much the most common of the crystalline rocks. Quartz is also much developed, generally mixed with mica, and rich in gold, mercury, specular iron, and sulphur. It sometimes extends several leagues in the western declivities of Peru, 6000 feet thick. Red sandstone, of vast dimensions, and of different geological periods, occurs in the Andes, and on the table-land east of them, where in some places, as in Colombia, it spreads over thousands of miles to the shores of the Atlantic. It is widely extended at altitudes of 10,000 and 12,000 feet: for example, on the table-lands of Tarqui and Cuenca. Coal is sometimes associated with it, and is found at Huenca in Peru, 14,750 feet above the sea.

Porphyry abounds all over the Andes, from Patagonia to Colombia, at every elevation, on the slopes and summits of the mountains, sometimes 19,000 feet thick, but not uniformly of the same age or nature. The variety of most frequent occurrence is rich in metals, while another is destitute of them. The bare and precipitous porphyry rocks give great variety to the colouring of the Andes, especially in Chili, where purple, tile-red, and brown are contrasted with the snow on the summit of the chain.\*

Trachyte is almost as abundant as porphyry. Many of the loftiest parts and all the great dome-shaped mountains in the Andes are formed of it. Masses of this rock, from 14,000 to 18,000 feet thick, are seen in Chimborazo and Pinchincha. Prodigious quantities of volcanic products, lava, tufa, and obsidian, occur on the western face of the Andes, where volcanoes are active. On the eastern side there are none. This is especially the case in that part of the chain lying between the equator and Chili. The Bolivian Cordilleras, which are the boundary of the valley of Desaguerado, furnish a striking example. The Cordillera

\* Dr. Pœppig.



of the coast is entirely composed of obsidian, trachyte, and tufa, while the eastern Cordillera consists of syenite, mica-schist, porphyry, and sandstone; marl, containing gypsum, oolitic limestone, and rock salt, of the most beautiful colours. Towards Chili and throughout the Chilian range the case is different, because active volcanoes are there in the centre of the chain.

Sea-shells of different geological periods are found at various elevations, which shows that many upheavings and subsidences have taken place in the chain of the Andes, especially at its southern extremity. Stems of large trees, which Mr. Darwin found in a fossil state in the Upsallata range, a collateral branch of the Chilian Andes, now 700 miles distant from the Atlantic, exhibit a remarkable example of such vicissitudes. These trees, with the volcanic soil on which they had grown, had sunk from the beach to the bottom of a deep ocean, from which, after five alternations of sedimentary deposits and deluges of submarine lava of prodigious thickness, the whole mass was raised up, and now forms the Upsallata chain. Subsequently by the wearing of streams, the imbedded trunks have been brought into view in a silicified state, projecting from the soil on which they grew—now solid rock.

“Vast and scarcely comprehensible as such changes must ever appear, yet they have all occurred within a period recent when compared with the history of the Cordillera; and the Cordillera itself is absolutely modern, compared with many of the fossiliferous strata of Europe and America.”\*

From the quantity of shingle and sand on the valleys in the lower ridges, as well as at altitudes from 7000 to 9000 feet above the present level of the sea, it appears that the whole area of the Chilian Andes has been raised by a gradual motion; and the coast is now rising by the same imperceptible degrees, though it is sometimes suddenly elevated by a succession of small upheavings of a few feet by earthquakes, similar to that which shook the continent for a thousand miles on the 20th of February, 1835.

On the eastern side of the Andes the land from Terra del Fuego to the Rio de la Plata has been raised *en masse* by

\* Darwin's Journal of Travels in South America.



one great elevating force, acting equally and imperceptibly for 2000 miles, within the period of the shell-fish now existing, which in many parts of these plains even still retain their colours. The gradual upward movement was interrupted by at least eight long periods of rest, marked by the edges of the successive plains, which, extending from south to north, had formed so many lines of sea-coast, as they rose higher and higher between the Atlantic and the Andes. It appears, from the shingle and fossil shells found on both sides of the Cordillera, that the whole south-western extremity of the continent has been rising slowly for a long time, and indeed the whole Andean chain.

The instability of the southern part of the continent is less astonishing if it be considered that at the time of the earthquake of 1835 the volcanoes in the Chilian Andes were in eruption contemporaneously for 720 miles in one direction, and 400 in another; so that in all probability there was a subterranean lake of burning lava below this end of the continent twice as large as the Black Sea.\*

The terraced plains of Patagonia, which extend hundreds of miles along the coast, are tertiary strata, not in basins, but in one great deposit, above which lies a thick stratum of white pumaceous substance, extending at least 500 miles, a tenth part of which consists of marine infusoria. Over the whole lies the shingle already mentioned, spread over the coast for 700 miles in length, with a mean breadth of 200 miles, and 50 feet thick. These myriads of pebbles, chiefly of porphyry, have been torn from the rocks of the Andes, and water-worn, at a period subsequent to the deposition of the tertiary strata—a period of incalculable duration. All the plains of Terra del Fuego and Patagonia, on both sides of the Andes, are strewn with huge boulders, transported by icebergs, which had descended to lower latitudes in ancient times than they do now—observations of great interest, which we owe to Mr. Darwin.

The stunted vegetation of these sterile plains was sufficient to nourish large animals of the pachydermata tribe, now extinct, even at a period when the present shell-fish of the Patagonian seas existed.

The Pampas of Buenos Ayres are entirely alluvial, the

\* Darwin's Journal of Travels in South America,



deposit of the Rio de la Plata. Granite prevails to the extent of 2000 miles along the coast of Brazil, and with syenite forms the base of the table-land. The superstructure of the latter consists of metamorphic and old igneous rocks, sandstone, clay-slate, limestone, in which are large caverns with bones of extinct animals, and alluvial soil. Gold is found in the channels of the rivers, and no country is so rich in diamonds.

The fertile soil of the Silvas has travelled from afar. Washed down from the Andes, it has been gradually deposited and manured by the decay of a thousand forests. Granite again appears in more than its usual ruggedness in the table-land and mountains of the Parima system. The sandstone of the Andes is found there also in a chain 7300 feet high; and on the plains of Esmeralda it caps the granite of the solitary prism-shaped Duido, the culminating mountain of the Parima system. Limestone appears in the Brigantine or Cocallar, the most southern of the three ranges of the coast-chain of Venezuela; the other two are of granite, metamorphic rocks, and crystalline schists, torn by earthquakes and worn by the sea, which has deeply indented that coast. The chain of islands in the Spanish main is merely the wreck of a more northern ridge, broken up into detached masses by these irresistible powers.

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## CHAPTER X.

### CENTRAL AMERICA—WEST INDIAN ISLANDS—GEOLOGICAL NOTICE.

TAKING the natural divisions of the continent alone into consideration, Central America may be regarded as lying between the 7th and 20th parallels of north latitude, and consequently in a tropical climate. The narrow tortuous strip of land which unites the continents of North and South America stretches from S.E. to N.W. about 1000 miles, varying in breadth from 30 miles to 300 or 400.

As a regular chain, the Andes terminate suddenly at the plain of Panama, but as a mass of high land they continue



through Central America and Mexico, in an irregular mixture of table-lands and mountains. These table-lands, however, differ from those in the Andes of South America, inasmuch as they are not bounded on each side by Cordilleras following the direction of the chain, but are traversed by ranges running over them in all directions, or studded by mountains. The mass of high land which forms the central ridge of the country, and the watershed between the two oceans, is very steep on its western side, and runs near the coast of the Pacific, where Central America is narrow; but to the north, where it becomes wider, the high land recedes to a greater distance from the shore than the Andes do in any other part between Cape Horn and Mexico.

The plains of Panama, very little raised above the sea, but in some parts studded with hills, follow the direction of the isthmus for 280 miles, and end at the Bay of Parita. From thence a mass, about 3000 feet high, of forest-covered table-lands and complicated mountains, extends through Veragua and Costa Rica to the Lake of Nicaragua. The plain of Nicaragua, together with its lake, occupies an area of 30,000 square miles, and forms the second break in the great Andean chain. The lake is only 128 feet above the Pacific, from which it is separated by a line of active volcanoes. The river San Juan de Nicaragua flows from its eastern end into the Caribbean Sea, and its northern extremity is connected with the smaller lake of Managua by the river Panalaya. By this water-line it has been projected to unite the two seas. The high land begins again, after an interval of 170 miles, with the Mosquito country and Honduras, which mostly consist of table-lands, high mountains, and some volcanoes.

The broad elevated belt of Guatemala lies between the Isthmus of Chiquimala and that of Tehuantepec. It spreads out to the east and forms the high but narrow table-land on the peninsula of Yucatan, which terminates at Cape Catoch, and which is bounded by high mountains and terraces along the Gulf of Honduras. The table-land of Guatemala consists of undulating verdant plains of great extent, of the absolute height of 5000 feet, fragrant with flowers. In the southern part of the table-land the cities of Old and New Guatemala are situated, 12 miles apart. The portion of the plain on which the new city stands is bounded on the west by the three volcanoes of Pacaya, del Fuego, and d'Agua;



these, rising from 7000 to 10,000 feet above the plain, lie close to the new city on the west, and form a scene of wonderful boldness and beauty. The Volcano de Agua, at the foot of which Old Guatemala stands, is a perfect cone, verdant to its summit, which occasionally pours forth torrents of boiling water and stones. The old city has been twice destroyed by it, and is now nearly deserted on account of violent earthquakes. The Volcano del Fuego generally emits smoke from one of its peaks, and the Volcano de Pacayo is only occasionally active. The wide grassy plains are cut by deep valleys to the north, where the high land of Guatemala ends in parallel ridges of mountains, called the Cerro Pelado, which run from east to west along the 94th meridian, filling half the Isthmus of Tehuantepec, which is 140 miles broad, and unites the table-land of Guatemala with that of Mexico.

Though there are large savannahs on the high plains of Guatemala, there are also magnificent primeval forests, as the name of the country implies, Guatemala, in the Mexican language, signifying a place covered with trees. The banks of the Rio de la Papian, or Usumasinta, which rises in the Alpine lake of Lacandon and flows over the table-land to the Gulf of Mexico, are beautiful beyond description.

The coasts of Central America are generally narrow, and in some places the mountains and high lands come close to the water's edge. The sugar-cane is indigenous, and on the low lands of the eastern coast all the ordinary produce of the West Indian Islands is raised, besides much that is peculiar to the country.

As the climate is cool on the high lands, the vegetation of the temperate zone is in perfection. On the low lands, as in other countries where heat and moisture are in excess, and where nature is for the most part undisturbed, vegetation is vigorous to rankness; forests of gigantic timber seek the free air above an impenetrable undergrowth, and the mouths of the rivers are dense masses of jungle with mangroves, and reeds 100 feet high: yet delightful savannahs vary the scene, and wooded mountains dip into the water.

Nearly all the coast of the Pacific is skirted by an alluvial plain, of small width, and generally very different in character from that on the Atlantic side. In a line along the western side of the table-land and the mountains, there is a continued succession of volcanoes, at various distances from the



shore, and at various heights, on the declivity of the tableland. It seems as if a great crack or fissure had been produced in the earth's surface, along the junction of the mountains and the shore, through which the internal fire had found a vent. There are more than 20 active volcanoes in succession, between the 10th and 20th parallels of north latitude, some higher than the mountains of the central ridge, and several subject to violent eruptions.

The Colombian Archipelago, or West Indian Islands, which may be regarded as the wreck of a submerged part of the continent of South and Central America, consists of three distinct groups, namely, the Lesser Antilles, or Caribbean Islands, the Greater Antilles, and the Bahama or Lucay Islands. Some of the Lesser Antilles are flat, but their general character is bold, with a single mountain or group of mountains in the centre, which slopes to the sea all around, more precipitously on the eastern side, which is exposed to the force of the Atlantic current. Trinidad is the most southerly of a line of magnificent islands, which form a semicircle, inclosing the Caribbean Sea, with its convexity facing the east. The row is single to the island of Guadaloup, where it splits into two chains, known as the Windward and Leeward Islands. Trinidad, Tobago, St. Lucia, and Dominica, are particularly mountainous, and the mountains are cut by deep narrow ravines, or gullies, covered by ancient forests. The volcanic islands, which are mostly in the single part of the chain, have conical mountains bristled with rocks of a still more rugged form; but almost all the islands of the Lesser Antilles have a large portion of excellent vegetable soil in a high state of cultivation. Most of them are surrounded by coral reefs, which render navigation dangerous, and there is little intercourse between these islands, and still less with the Greater Antilles, on account of the prevailing winds and currents, which make it difficult to return. The Lesser Antilles terminate with the group of the Virgin Islands, which are small and flat, some only a few feet above the sea, and most of them are mere coral rocks.

The four islands which form the group of the Greater Antilles, are the largest and finest in the archipelago. Porto Rico, Haiti, and Jamaica, separated from the Virgin Islands by a narrow channel, lie in a line parallel to the coast-chain of Venezuela, from east to west; while Cuba,



by a serpentine bend, separates the Caribbean Sea, or Sea of the Antilles, from the Gulf of Mexico. Porto Rico is 140 miles long and 36 broad, with wooded mountains passing through its centre nearly from east to west, which furnish abundance of water. There are extensive savannahs in the interior, and very rich soil on the northern coast, but the climate is unhealthy.

Haiti, 450 miles long and 110 broad, has a group of mountains in its centre, the highest of which is 9000 feet above the sea. Chains diverge from this nucleus to the remotest parts of the island, so that there is a great proportion of high land. The mountains are susceptible of cultivation nearly to the summits, and they are clothed with undisturbed tropical forests. The extensive plains are well watered, and the soil though not deep is productive.

Jamaica, the most valuable of the British possessions in the West Indies, has an area of 4256 square miles, of which 110,000 acres are cultivated chiefly as sugar-plantations. The principal chain of the Blue Mountains lies in the centre of the island, from east to west, 5000 or 6000 feet above the sea, with so sharp a crest that in some places it is only four yards across. The offsets from it cover all the eastern part of the island; some of them are 7000 feet high. The more elevated ridges are flanked by lower ranges, descending to verdant savannahs. The escarpments are wild, the declivities steep, and mingled with stately forests. The valleys are very narrow, and not more than a twentieth part of the island is level ground. There are many small rivers, and the coast-line is 500 miles long, with at least 30 good harbours. The mean summer heat is  $80^{\circ}$  of Fahrenheit, and that of winter  $75^{\circ}$ . The plains are often unhealthy, but the air on the mountains is salubrious; fever has never prevailed at the elevation of 2500 feet.

Cuba, the largest island in the Colombian Archipelago, has an area of 42,212 square miles, and 200 miles of coast, but so beset with coral reefs, sand-banks and rocks, that only a third of it is accessible. Its mountains, which attain the height of 8000 feet, occupy the centre, and fill the eastern part of the island, in a great longitudinal line. No island in these seas is more important with regard to situation and natural productions; and although much of the low ground is swampy and unhealthy, there are vast savannahs, and about a seventh part of the island is cultivated.



The Bahama Islands are the least valuable and least interesting part of the Archipelago. The group consists of about 500 islands, many of them mere rocks, lying east from Cuba and the coast of Florida. Twelve are rather large, and cultivated; and though arid, they produce Campeche wood and mahogany. The most intricate labyrinth of shoals and reefs, chiefly of corals, madrepores, and sand, encompass these islands; some of them rise to the surface, and are adorned with groves of palm-trees. The Great Bahama Island is the first part of the New World on which Columbus landed; the next was Haiti, where his ashes rest.

The geology of Central America is little known; nevertheless it appears, from the confused mixture of table-lands and mountain-chains in all directions, that the subterraneous forces must have acted more partially and irregularly than either in South or North America. Granite, gneiss, and mica-slate form the substrata of the country; but the abundance of igneous rocks bears witness to strong volcanic action, both in ancient and in modern times, which still maintains its activity in the volcanic groups of Guatemala and Mexico.

From the identity of the fossil remains of extinct quadrupeds, there is every reason to believe that the West Indian Archipelago was once part of South America, and that the rugged and tortuous isthmus of Central America, and the serpentine chain of islands winding from Cumana to the peninsula of Florida, are but the shattered remains of an unbroken continent. The powerful volcanic action in Central America and Mexico, the volcanic nature of many of the West Indian Islands, and the still-existing fire in St. Vincent's, together with the tremendous earthquakes to which the whole region is subject, render it more than probable that the Caribbean Sea and the Gulf of Mexico are one great area of subsidence, which possibly has been increased by the erosion of the Gulf-stream and ground-swell—a temporary current of great impetuosity, common among the West Indian Islands from October to May.

The subsidence of this extensive area must have been very great, since the water is of profound depth between the islands, and it must have taken place after the destruction of the great quadrupeds, and consequently at a very recent



geological period. The elevation of the table-land of Mexico may have been a contemporaneous event. The action in the Colombian Archipelago is now, however, in a contrary direction, as the bed of the ocean is rising there. The line of volcanic islands begins with St. Vincent's, and ends with Guadaloup; the island of St. Eustasius in the Leeward range is also volcanic. The Windward and Bahama Islands are of calcareous and coral rocks. The Greater Antilles are both crystalline and calcareous in their principal mountain-chains, which are all parallel to the great chain of Venezuela, with the exception of Cuba, where the mountains diverge from a central nucleus to its extremities: there is a region of serpentine, rich in minerals, in one part of the island, with an extensive formation of columnar white marble adjacent to it.

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## CHAPTER XI.

NORTH AMERICA—TABLE-LAND AND MOUNTAINS OF MEXICO  
—THE ROCKY MOUNTAINS—THE MARITIME CHAIN AND  
MOUNTAINS OF RUSSIAN AMERICA.

ACCORDING to the natural division of the continent, North America begins about the 20th degree of north latitude, and terminates in the Arctic Ocean. It is longer than South America, but the irregularity of its outline renders it impossible to estimate its area. Its greatest length is about 3100 miles, and its breadth, at the widest part, is 3500 miles.

The general structure of North America is still more simple than that of the southern part of the continent. The table-land of Mexico and the Rocky Mountains, which are the continuation of the high land of the Andes, run along the western side, but at a greater distance from the Pacific; and the immense plains to the east are divided longitudinally by the Alleghany Mountains, which stretch from the Carolinas to the Gulf of St. Lawrence, parallel to the Atlantic, and at no great distance from it. Although the general direction of the two chains is from south to north, yet, as they maintain a degree of parallelism to the two coasts, they diverge



towards the north, one inclining towards the north-west, and the other towards the north-east. The long narrow plain between the Atlantic and the Alleghanies is divided, throughout its length, by a line of cliffs not more than 200 or 300 feet above the Atlantic plain—the outcropping edge of the Second Terrace, or Atlantic Slope, whose rolling surface goes west to the foot of the mountains.

An enormous table-land occupies the greater part of Mexico, or Anahuac. It begins at the Isthmus of Tehuantepec, and extends north-west to the 42d parallel of north latitude, a distance of 1600 miles, which is nearly equal to the distance from the north extremity of Scotland to Gibraltar. It is narrow towards the south, but expands towards the north-west till about the latitude of the city of Mexico, where it attains its greatest breadth of 360 miles, and there also it is highest. The most easterly part in that parallel is 7500 feet above the sea, from whence it rises towards the west to the height of 9000 feet at the city of Mexico, and then gradually diminishes to 4000 feet towards the Pacific.

Its height in California is not known, but it still bears the character of a table-land, and maintains an elevation of 6000 feet along the east side of the Sierra Madre, even to the 32d degree of north latitude, where it sinks to a lower level before joining the Rocky Mountains. The descent from this plateau to the low lands is very steep on all sides; on the east, especially, it is so precipitous that, from a distance, it is like a range of high mountains. There are only two carriage-roads to it from the Mexican Gulf, by passes 500 miles asunder: one at Xalapa, near Vera Cruz; the other at Santilla, west of Monterey. The descent to the shores of the Pacific is almost equally rapid, and that to the south no less so, where, for 300 miles between the plains of Tehuantepec and the Rio Yapez, it presses on the shores of the Pacific, and terminates in high mountains, leaving only a narrow margin of hilly maritime coast. Where the surface of the table-land is not traversed by mountains it is as level as the ocean. There is a carriage-road over it for 1500 miles, without hills, from the city of Mexico to Sante Fé.

The southern part of the plateau is divided into four parts, or distinct plains, surrounded by hills from 500 to 1000 feet high. In one of these, the plain of Tolesco, on a small group of islands near the eastern bank of the Lake Tetzcuco,



and surrounded by a wall of porphyritic mountains, stands the city of Mexico, once the capital of the empire of Montezuma, which must have far surpassed the modern city in extent and splendour, as many remains of its ancient glory testify. It is 9000 feet above the sea, which is the height of Mount St. Bernard.

One of the singular crevices through which the internal fire finds a vent stretches from the Gulf of Mexico to the Pacific, directly across the table-land, in a line about 16 miles south of the city of Mexico. A very remarkable row of active volcanoes occurs along this parallel. Turtla, the most eastern of them, is in the 95th degree west longitude, near the Mexican Gulf, in a low range of wooded hills. More to the west the snow-shrouded cone of Orizabo is 17,000 feet high; and its ever-fiery crater, seen like a star in the darkness of the night, has obtained it the name of Citlaltepétl, the "Mountain of the Star." Popocatepetl, the loftiest mountain in Mexico, 17,884 feet above the sea, lies still farther west, and is in a state of constant eruption. A chain of smaller volcanoes unites the three. On the western slope of the table-land, 36 leagues from the Pacific, stands the volcanic cone of Jorullo, on a plain 2890 feet above the sea. It suddenly appeared and rose 1683 feet above the plain on the night of the 29th of September, 1759. The great cone of Colima, the last of this volcanic series, stands insulated in the plain of that name, between the western declivity of the table-land and the Pacific.

A high range of mountains extends along the eastern margin of the table-land to Real de Catorce, and the surface of the high plain is divided into two parts by the Sierra Madre, which begins at 21 degrees north latitude; and, after going north about 60 miles, its continuity is broken into the insulated ridges of the Sierra Altamina, and the group containing the mines of Zacatecas; it soon after resumes its character of a regular chain, and, with a breadth of 100 miles, proceeds in parallel ridges and longitudinal valleys to New Mexico, where it skirts both banks of the Rio Bravo del Norte, and joins the Sierra Verde, the most southern part of the Rocky Mountains, in 40 degrees north latitude.

To the south some points of the Sierra Madre are said to be 10,000 feet high, and 4000 above their base; and be-



tween the parallels of 36 and 42 degrees, where the chain is the watershed between the Rio Colorado and the Rio Bravo del Norte, they are still higher, and perpetually covered with snow. The mountains on the left bank of the last-mentioned river are the eastern ridges of the Sierra Madre, and contain the sources of the innumerable affluents of the Missouri and other rivers that flow into the Mississippi and Mexican Gulf.

Deep cavities, called Barancas, are a characteristic feature of the table-lands of Mexico. They are long narrow rents two or three miles in breadth, and many more in length, often descending 1000 feet below the surface of the plain, with a brook or the tributary of some river flowing through them. Their sides are precipitous and rugged, with overhanging rocks covered with large trees. The intense heat adds to the contrast between these hollows and the bare plains, where the air is more than cool.

Vegetation varies with the elevation: consequently the splendour which adorns the low lands vanishes on the high plains, which, though producing much grain and pasture, are often saline, sterile, and treeless, except in some places, where oaks grow to an enormous size free of underwood.

The Rocky Mountains run 1500 miles, in two parallel chains, from the Sierra Verde to the mouth of the Mackenzie River, in the Arctic Ocean, sometimes united by a transverse ridge. In some places the eastern range rises to the snow-line, and even far above it, as in Mounts Hooper and Brown, 15,590 and 16,000 feet above the sea; but the general elevation is only above the line of trees. The western range is not so high till north of the 55th parallel, where both ranges are of the same height, and frequently higher than the snow-line. They are generally barren, though the transverse valleys have fertile spots with grass, and sometimes trees. The long valley between the two rows of the Rocky Mountains, which is 100 miles wide, must have considerable elevation in the south, since the tributaries of the Colombia River descend from it in a series of rapids and cataracts for nearly 100 miles; and it is probably still higher towards the sources of the Peace River, where the mountains, only 1500 feet above it, are perpetually covered with snow. The Sierra Verde is 670 miles from the Pacific; but, as the coast trends due north to the Sound of Juan de



Fuca, the western range of the Rocky Mountains maintains a distance of 380 miles from the ocean, from that point to the latitude of Behring's Bay in 60 degrees north latitude.

Offsets from the Sierra Madre, and the volcanic group of Castres Virgines, fill the peninsula of California, from whence, to the Sound of Juan de Fuca, the Pacific is bordered by snow-clad mountains. Prairies extend between this coast-chain and the Rocky Mountains from California to north of the Oregon River. The Oregon coast for 200 miles is a mass of undisturbed forest-thickets and marshes, and north from it, with few exceptions, is a mountainous region of bold aspect, often reaching above the snow-line. The maritime chain of Russian America, of a still more Alpine character, runs due north to 60 degrees of north latitude, where Mount Elias rises to 17,000 feet. The branch which runs westward to Bristol Bay has many active volcanoes, and so has that which fills the promontory of Alaska.

The archipelagos and islands along the coast, from California to the promontory of Alaska, have the same bold character as the mainland, and may be regarded as the tops of a submarine chain of table-lands and mountains, which constitute the most westerly ridge of the maritime chains. Prince of Wales's Archipelago contains seven active volcanoes.

The mountains on the coasts of the Pacific, and the islands, are, in many places, covered with colossal forests, but wide tracts in the south are sandy deserts.

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## CHAPTER XII.

NORTH AMERICA (*continued*).—THE GREAT CENTRAL PLAINS OR VALLEY OF THE MISSISSIPPI—THE ALLEGHANY MOUNTAINS—THE ATLANTIC SLOPE—THE ATLANTIC PLAIN—GEOLOGICAL NOTICE.

THE great central plain of North America, lying between the Rocky and Alleghany Mountains, and reaching from the Gulf of Mexico to the Arctic Ocean, includes the valleys of the Mississippi, St. Lawrence, Nelson, Churchill, and most



of those of the Missouri, Mackenzie's, and Coppermine rivers. It has an area of 3,240,000 square miles, which is 240,000 square miles more than the central plain of South America, and about half the size of the great plain of the Old Continent, which is less fertile; for, although the whole of America is not more than half the size of the Old Continent, it contains at least as much productive soil.

This plain, 5000 miles long, becomes wider towards the north, and has no elevations, except a low table-land which crosses it at the line of the Canadian lakes and the sources of the Mississippi, and is nowhere above 1500 feet high, and rarely more than 700. The character of the plain is that of perfect uniformity, rising by a gentle regular ascent from the Gulf of Mexico to the sources of the Mississippi, which river is the great feature of the North American low lands. The ground rises in the same equable manner from the right bank of the Mississippi to the foot of the Rocky Mountains, but its ascent from the left bank to the Alleghanies is broken into hill and dale, containing the most fertile territory in the United States. Under so wide a range of latitude the plain embraces a great variety of soil, climate, and productions; but, being almost in a state of nature, it is characterized in its middle and southern parts by interminable grassy savannahs, or prairies, and enormous forests; and in the far north by deserts which rival those of Siberia in dreariness.

In the south a sandy desert, 400 or 500 miles wide, stretches along the base of the Rocky Mountains to the 41st degree N. lat. The dry plains of Texas and the upper region of the Arkansas have all the characteristics of Asiatic table-lands; more to the north the bare, treeless steppes on the high grounds of the far west are burnt up in summer, and frozen in winter by biting blasts from the Rocky Mountains; but the soil improves towards the Mississippi. At its mouth, indeed, there are marshes which cover 35,000 square miles, bearing a rank vegetation, and its delta is a labyrinth of streams and lakes, with dense brushwood. There are also large tracts of forest and saline ground, but all the cultivation on the right bank of the river is along the Gulf of Mexico and in the adjacent provinces, and is entirely tropical, consisting of sugar-cane, cotton, and indigo. The prairies, so characteristic of North America, then begin.

To the left of the Mississippi these savannahs are some-



times rolling, but oftener level and interminable as the ocean, covered with long rank grass of tender green, blended with flowers chiefly of the liliaceous kind, which fill the air with their fragrance. In the southern districts they are sometimes interspersed with groups of magnolia, tulip and cotton-trees, and in the north, oaks and black walnut. These are rare occurrences, as the prairies may be traversed for many days without finding a shrub, except on the banks of the streams, which are beautifully fringed with myrtle, azalea, kalmea, andromeda, and rhododendron. On the wide plains the only objects to be seen are countless herds of wild horses, buffaloes and deer. The country assumes a more severe aspect in higher latitudes. It is still capable of producing rye and barley in the territories of the Assinniboines, and round Lake Winnepeg there are great forests; a low vegetation, with grass, follows, and towards the Icy Ocean the land is barren and covered with numerous lakes.

East of the Mississippi there is a magnificent undulating country about 300 miles broad, extending 1000 miles from south to north between that great river and the Alleghany Mountains, mostly covered with trees. When America was discovered, one uninterrupted forest spread over the country from the Gulf of St. Lawrence and the Canadian lakes to the Gulf of Mexico, and from the Atlantic Ocean it crossed the Alleghany Mountains, descended into the valley of the Mississippi on the north, but in the south it crossed the main stream of that river altogether, forming an ocean of vegetation of more than 1,000,000 square miles, of which the greater part still remains. Although forests occupy so much of the country, there are immense prairies on the east side of the river also. Pine-barrens, stretching far into the interior, occupy the whole coast of the Mexican Gulf eastward from the Pearl River, through Alabama and a great part of Florida.

These vast monotonous tracts of sand, covered with forests of gigantic pine-trees, are as peculiarly a distinctive feature of the continent of North America as the prairies, and are not confined to this part of the United States; they occur to a great extent in North Carolina, Virginia, and elsewhere. Tennessee and Kentucky, though much cleared, still possess large forests, and the Ohio flows for hundreds of miles among magnificent trees, with an undergrowth of azaleas,



rhododendrons, and other beautiful shrubs, matted together by creeping plants. There the American forests appear in all their glory, the gigantic deciduous cypress, and the tall tulip-tree, overtopping the forest by half its height, a variety of noble oaks, black walnuts, American plane, hiccory, sugar-maple, and the lyriodendron, the most splendid of the magnolia tribe, the pride of the forest.

The Illinois waters a country of prairies ever fresh and green, and five new states are rising round the great lakes, whose territory of 280,000 square miles contains 180,000,000 acres of land, of excellent quality. These states, still mostly covered with wood, lie between the lakes and the Ohio, and they reach from the United States to the Upper Mississippi—a country twice as large as France, and six times the size of England.

The quantity of water, in the north-eastern part of the central plain, greatly preponderates over that of the land; the five principal lakes, Huron, Superior, Michigan, Erie, and Ontario, cover an area equal to Great Britain, without reckoning small lakes and rivers innumerable.

The Canadas contain millions of acres of good soil, covered with immense forests. Upper Canada is the most fertile, and in many respects is one of the most valuable of the British colonies in the west: every European grain, and every plant that requires a hot summer, and can endure a cold winter, thrives there. The forests consist chiefly of black and white spruce, the Weymouth and other pines—trees which do not admit of undergrowth: they grow to great height, like bare spars, with a tufted crown, casting a deep gloom below. The fall of large trees from age is a common occurrence, and not without danger, as it often causes the destruction of those adjacent, and an ice-storm is awful.

After a heavy fall of snow, succeeded by rain and a partial thaw, a strong frost coats the trees and all their branches with transparent ice, often an inch thick: the noblest trees bend under the load, icicles hang from every bough, which come down in showers with the least breath of wind. The hemlock-spruce especially, with its long drooping branches, is then like a solid mass. If the wind freshens, the smaller trees become like corn beaten down by the tempest, while the large ones swing heavily in the breeze. The forest at last gives way under its load: tree comes down after tree



with sudden and terrific violence, crushing all before them, till the whole is one wide uproar, heard from afar like successive discharges of artillery. Nothing, however, can be imagined more brilliant and beautiful than the effect of sunshine in a calm day on the frozen boughs, where every particle of the icy crystals sparkles, and nature seems decked in diamonds.\*

Although the subsoil is perpetually frozen at the depth of a few feet below the surface, beyond the 56th degree of north latitude, yet trees grow in some places up to the 64th parallel. Farther north, the gloomy and majestic forests cease, and are succeeded by a bleak, barren waste, which becomes progressively more dreary as it approaches the Arctic Ocean. Four-fifths of it are like the wilds of Siberia in surface and climate, covered many months in the year with deep snow. During the summer it is the resort of herds of rein-deer and buffaloes, which come from the south to browse on the tender shore grass which then springs up along the streams and lakes.

The Alleghany or Appalachian chain, which constitutes the second or subordinate system of North American mountains, separates the great central plain from that which lies along the Atlantic Ocean. Its base is a strip of table-land from 1000 to 3000 feet high, lying between the sources of the rivers Alabama and Yazan, in the southern states of the Union, and New Brunswick, at the mouth of the river St. Lawrence. This high land is traversed throughout 1000 miles, between Alabama and Vermont, by from three to five parallel ridges of low mountains rarely more than 3000 or 4000 feet high, and separated by fertile longitudinal valleys, which occupy more than two-thirds of its breadth of 100 miles. In Virginia and Pennsylvania, the only part of the chain to which the name of the Alleghany Mountains properly belongs, it is 150 miles broad; and the whole is computed to have an area of 2,000,000 square miles. The parallelism of the ridges, and the uniform level of their summits, are the characteristics of this chain, which is lower and less wild than the Rocky Mountains. The uniformity of outline in the southern and middle parts of the chain is very remarkable, and results from their peculiar structure.† These mountains have no central axis, but consist of a series of convex

\* Mr. Taylor.

† Mr. Lyell's America.



and concave flexures, forming alternate hills and longitudinal valleys, running nearly parallel throughout their length, and cut transversely by the rivers that flow to the Atlantic on one hand, and to the Mississippi on the other. The water-shed nearly follows the windings of the coast, from the point of Florida to the north-western extremity of the State of Maine.

The picturesque and peaceful scenery of the Appalachian Mountains is well known; they are generally clothed with a luxuriant and varied vegetation, and their western slope is considered one of the finest countries in the United States. To the south they maintain a distance of 200 miles from the Atlantic, but approach close to the coast in the south-eastern part of the state of New York, from whence their general course is northerly to the river St. Lawrence. They fill the Canadas, Maine, New Brunswick, and Nova Scotia with branches as high as the mean elevation of the principal chain, and extend even to the dreary regions of Baffin's Bay. Not only the deep forests, but vegetation in general, diminish as the latitude increases, till on the Arctic shores the soil becomes incapable of culture, and the majestic forest is superseded by the Arctic birch which creeps on the ground. The islands along the north-eastern coasts have more than the mildness of the main-land. Though little favoured by nature, many of them produce flax and timber; and Newfoundland, as large as England and Wales, maintains a population of 70,000 souls by its fisheries; it is nearer to Britain than any part of America—the distance from the port of St. John to the harbour of Valentia in Ireland is only 1655 nautical miles.

The long and comparatively narrow plain which lies between the Appalachian Mountains and the Atlantic, extends from the Gulf of Mexico to the eastern coast of Massachusetts. At its southern extremity it joins the plain of the Mississippi, and gradually becomes narrower in its northern course to New England, where it merely includes the coast islands. It is divided throughout its length by a line of cliffs from 200 to 300 feet high, which begins in Alabama, and ends in the coast of Massachusetts. This escarpment is the eastern edge of the terrace known as the Atlantic Slope, which rises above the Maritime or Atlantic Plain, and undulates westward to the foot of the Blue Mountains, the most eastern ridge of the Appalachian Chain. It is narrow at its



extremities in Alabama and New York, but in Virginia and the Carolinas it is 200 miles wide. The surface of the slope is of great uniformity; ridges of hills and long valleys run along it parallel to the mountains, close to which it is 600 feet high. It is rich in soil and cultivation, and has an immense water-power in the streams and rivers flowing from the mountains across it, which are precipitated over its rocky edge to the plains on the west. More than twenty-three rivers of considerable size fall in cascades down this ledge between New York and the Mississippi, affording scenes of great beauty.

Both land and water assume a new aspect on the Atlantic Plain. The rivers, after dashing over the rocky barrier, run in tranquil streams to the ocean, and the plain itself is a monotonous level, not more than a hundred feet above the surface of the sea. Along the coast it is scooped into valleys and ravines, with innumerable creeks.

The greater part of the magnificent countries east of the Alleghanies is in a high state of cultivation and commercial prosperity, with natural advantages not surpassed in any country. Nature, however, still maintains her sway in some parts, especially where pine-barrens and swamps prevail. The territory of the United States occupies 7,000,000 or 8,000,000 square miles, the greater part of it capable of producing every thing that is useful to man, but not more than the twenty-sixth part of it has been cleared; the climate is healthy, the soil fertile, abounding in mineral treasures, and it possesses every advantage from navigable rivers and excellent harbours. The outposts of civilization have already advanced half way to the Pacific, and the tide of white men is continually and irresistibly pressing onwards to the ultimate extinction of the original proprietors of the soil—a melancholy, but not a solitary instance of the rapid extinction of a whole race.

Crystalline and silurian rocks, rich in precious and other metals, form the substratum of Mexico, for the most part deeply covered with plutonic and volcanic formations and secondary limestone; yet granite comes to the surface on the coast of Acapulca, and occasionally on the plains and mountains of the table-land. The Rocky Mountains are mostly silurian, except the eastern ridge which is of stratified crystalline rocks, amygdaloid and ancient volcanic pro-



ductions. The coast-chain has the same character, with immense tracts of volcanic rocks, both ancient and modern, especially obsidian, which is nowhere developed on a greater scale, except in Mexico and the Andes.

In North America, as in the southern part of the continent, volcanic action is entirely confined to the coast and highland along the Pacific. The numerous vents in Mexico and California are often in great activity, and hot springs abound. Though a considerable interval occurs north of these, where the fire is dormant, the country is full of igneous productions, and it again finds vent in Prince of Wales's Island, which has seven active volcanoes. From Mount St. Elias westward through the whole southern coast of the peninsula of Russian America and the Aleutian Islands, which form a semicircle between Cape Alaska, in America, and the peninsula of Kamschatka, volcanic vents occur, and in the latter peninsula there are three of great height.

From the similar nature of the coasts, and the identity of the fossil mammalia on each side of Behring's Strait, it is more than probable that the two continents were united even since the sea was inhabited by the existing species of shell-fish. Some of the gigantic quadrupeds of the Old Continent are supposed to have crossed either over the land or over the ice to America, and to have wandered southward through the longitudinal valleys of the Rocky Mountains, Mexico, and Central America, and to have spread over the vast plains of both continents, even to their utmost extremity. An extinct species of horse, the mastodon, a species of elephant, three gigantic edentata, and a hollow-horned ruminating animal, roamed over the pampas of the southern continent, and the prairies of the northern; certainly since the sea was peopled by its present inhabitants, probably even since the existence of the Indians. The skeletons of these creatures are found in great numbers in the saline marshes on the prairies called the Licks, which are still the resort of the existing races.

There were, however, various animals peculiar to America, as well as to each part of that continent, at least as far as yet known. South America still retains in many cases the type of its ancient inhabitants, though on a very reduced scale. But on the Patagonian plains and on the pampas, skeletons of creatures of gigantic size and anomalous forms



have been found ; one like an ant-eater of great magnitude, covered with a prodigious coat of mail similar to that of the armadillo ; others like gigantic rats or mice, perhaps the largest animals yet discovered,—all of which had lived on vegetables, and had existed at the same time with those already mentioned. These animals were not destroyed by the agency of man, since creatures not larger than a rat vanished from Brazil within the same period.

The geological outline of the United States, the Canadas, and all the country to the Polar Ocean, though highly interesting in itself, becomes infinitely more so when viewed in connection with that of northern and middle Europe. A remarkable analogy exists in the structure of the land on each side of the north Atlantic basin. Gneiss, mica-schist, and occasional granite, prevail over wide areas in the Alleghanies, on the Atlantic slope, and still more in the northern latitudes of the American continent ; and they range also through the greater part of Scandinavia, Finland, and Lapland. In the latter countries, and in the more northern parts of America, Mr. Lyell has observed that the fossiliferous rocks belong either to the most ancient or to the newest formation, to the Silurian strata, or to such as contain shells of recent species only, no intermediate formation appearing through immense regions. Silurian strata extend over 2000 miles in the middle and high latitudes of North America ; they occupy a tract nearly as great between the most westerly headlands of Norway and those that separate the White Sea from the Polar Ocean ; and Sir Roderick Murchison has traced them through central and eastern Europe, and the Ural Mountains, even to Siberia. Throughout these vast regions, both in America and Europe, the Silurian strata are followed in ascending order by the Devonian and carboniferous formations, which are developed on a stupendous scale in the United States, chiefly in the Alleghany Mountains and on the Atlantic slope. The Devonian and carboniferous strata together are a mile and a half thick in New York, and three times as much in Pennsylvania, where one single coal-field occupies 63,000 square miles between the northern limits of that State and Alabama. There are many others of great magnitude, both in the States and to the north of them, so that the most valuable of all minerals is here inexhaustible, which is not the least



of the many advantages enjoyed by that flourishing country. The coal formation is also developed in New Brunswick, and traces of it are found on the shores and in the islands of the Polar Ocean, on the east coast of Greenland, and even in Spitzbergen.

Vast carboniferous basins exist in Belgium above the Silurian strata ; and a great portion of Britain is perfectly similar in structure to North America. The Silurian rocks in many instances are the same ; and the coal-fields of New England are precisely similar to those in Wales, 3000 miles off. It would be difficult to estimate the quantity of coal in Britain and Ireland, but there is probably enough to last for some thousand years. If science continues to advance as it has lately done, a substitute will in all probability be discovered before the coal is exhausted.

In all the more northern countries that have been mentioned, so very distant from one another, the general range of the rocks is from north-east to south-west ; and in northern Europe, the British isles, and North America, great lakes are formed along the junction of the strata, the whole analogy affording a proof of the wide diffusion of the same geological conditions in the northern regions at a very remote period. At a later time those erratic blocks, which are now scattered over the higher latitudes of both continents, were most likely brought from the north by drift ice or currents, while the land was still covered by the deep. Volcanic agency has not been wanting to complete the analogy. The Silurian and overlying strata have been pierced in many places by trap-pean rocks in both continents, and they appear also in the islands of the North Atlantic and Polar Seas. Even now the volcanic fires are in great activity in the very centre of that basin in Iceland, and in the very distant and less known island of Jan Mayen's Land.

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## CHAPTER XIII.

GREENLAND—SPITZBERGEN—ICELAND—JAN MAYEN'S LAND—  
ANTARCTIC LANDS—VICTORIA CONTINENT.

GREENLAND, the most extensive of the Arctic lands, begins with the lofty promontory of Cape Farewell, the southern



extremity of a group of rocky islands, which are separated by a channel five miles wide from a table-land of appalling aspect, narrow to the south, but increasing in breadth northward to a distance of which only 1300 miles are known. This table-land is bounded by mountains rising from the deep in mural precipices, which terminate in needles and pyramids, or in parallel terraces of alternate snow and bare rock, occasionally leaving a narrow shore. The coating of ice is so continuous and thick that the surface of the table-land may be regarded as one enormous glacier, which overlaps the rocky edges and dips between the mountain peaks into the sea.

The coasts are beset with rocky islands, and cloven by fiords which, in some instances, wind like rivers for 100 miles into the interior. These deep inlets of the sea, now sparkling in sunshine, now shaded in gloom, are hemmed in by walls of rock often 2000 feet high, whose summits are hid in the clouds. They generally terminate in glaciers, which are sometimes forced on by the pressure of the upper ice plains till they fill the fiord and even project far into the sea like bold headlands, when, undermined by the surge, huge masses of ice fall from them with a crash like thunder, making the sea boil. These icebergs, carried by currents, are stranded on the Arctic coast, or are driven into lower latitudes. The ice is very transparent and compact in the Arctic regions: its prevailing tints are blue, green, and orange, which, contrasted with the dazzling whiteness of the snow and the gloomy hue of the rocks, produce a striking effect.

A great fiord in the 68th parallel of latitude is supposed to extend completely across the table-land, dividing the country into south and north Greenland, which last extends indefinitely towards the pole, but it is altogether inaccessible from the frozen sea and the iron-bound shore, so that, excepting a very small portion of the coast, it is an unknown region.

In some sheltered spots in south Greenland, especially along the borders of the fiords, there are meadows where the service-tree bears fruit; beech and willow trees grow by the streams, but not taller than a man; and still farther north the willow and juniper scarcely rise above the surface; yet this country has a flora peculiar to itself. South of the



island of Disco, on the west coast, Danish colonies and missionaries have made settlements on some of the islands, and at the mouths of fiords; the Esquimaux inhabit the coasts even to the extremity of Baffin's Bay.

The aspect of other Arctic lands is like that of Greenland. In the island of Spitzbergen the mountains spring sharp and grand from the margin of the sea in dark gloomy masses, mixed with pure snow and enormous glaciers, presenting a sublime spectacle. The sun is not seen for several months in the year, when the intensity of the cold splits rocks and makes the sea reek like a boiling caldron. Many have perished in the attempt to winter in this island, yet a colony of Russian hunters and fishermen lead a miserable existence there within  $10^{\circ}$  of the pole—the most northern inhabited spot on the globe.

Although the direct rays of the sun are powerful in sheltered spots within the Arctic circle, the thermometer does not rise above  $45^{\circ}$  of Fahrenheit. July is the only month in which snow does not fall, and in the end of August the sea at night is covered with a thin coating of ice, and a summer often passes without one day that can be called warm. The snow-blink, the aurora, the stars, and the moon, which appears ten or twelve days without intermission in her northern declination, furnish the greatest light the inhabitants enjoy in their long winter.

Iceland is 200 miles east from Greenland, and lies south of the Arctic Circle, which its most northern point touches. Though a fifth part larger than Ireland, not more than 4000 square miles are habitable; all besides being a chaos of volcanoes and ice.\*

The peculiar feature of Iceland lies in a trachytic region, which seems to rest on an ocean of fire. It consists of two vast parallel table-lands covered with ice-clad mountains, stretching from N.E. to S.W. through the very centre of the island, separated by a longitudinal valley nearly 100 miles wide, which reaches from sea to sea. These mountains assume rounded forms with long level summits, or domes with sloping declivities, as in the trachyte mountains of the Andes and elsewhere; but such huge masses of tufa and conglomerate project from their sides in perpendicular or

\* Trevelyan's Travels in Iceland.



overhanging precipices, separated by deep ravines, that the regularity of their structure can only be perceived from a distance: they conceal under a cold and tranquil coating of ice the fiery germs of terrific convulsions, sometimes bursting into dreadful activity, sometimes quiescent for ages. The most extensive of the two parallel ranges of Jokuls or Ice Mountains runs along the eastern side of the valley, and contains Ordefa, the highest point in Iceland, seen like a white cloud from a great distance at sea; the western high land passes through the centre of the island.

Glaciers cover many thousand square miles in Iceland, descending from the mountains and pushing far into the low lands. This tendency of the ice to encroach has very materially diminished the quantity of habitable ground, and the progress of the glaciers is facilitated by the influence of the ocean of subterranean fire, which heats the superincumbent ground and loosens the ice.

The longitudinal space between the mountainous tablelands is a low valley 100 miles wide, extending from sea to sea, where a substratum of trachyte is covered with lava, sand, and ashes, studded with low volcanic cones. It is a tremendous desert, never approached without dread even by the natives; a scene of perpetual conflict between the antagonist powers of fire and frost, without a drop of water or a blade of grass: no living creature is to be seen, not a bird nor even an insect. The surface is a confused mass of streams of lava rent by crevices; and rocks piled on rocks, with occasional glaciers, complete the scene of desolation.

As herds of rein-deer are seen browsing on the Iceland moss that grows plentifully at its edges, it may be presumed that some unknown parts may be less barren. The extremities of the valley are more especially the theatres of perpetual volcanic activity. At the southern end, which opens to the sea in a wide plain, there are many volcanoes, of which Hekla is most known, from its insulated position, its vicinity to the coast, and its tremendous eruptions. The cone is divided into three peaks by crevices which are filled with snow: one of the fissures cleaves the mountain from the summit to the base; it is supposed to have been produced by the great eruption of 1300. Between the years 1004 and 1766 twenty-three violent eruptions have taken place, one of which continued six years, spreading devastation over a country once



the abode of a thriving colony, now covered with lava, scorïæ, and ashes; and in the year 1846 it was in full activity. The eruption of Skaptar, which broke out on the 8th of May, 1783, and continued till August, is one of the most dreadful recorded. The sun was hid many days by dense clouds of vapour, which extended to England and Holland, and the quantity of matter thrown out in this eruption was computed at fifty or sixty thousand millions of cubic yards. Some rivers were heated to ebullition, others dried up; the condensed vapour fell in snow and torrents of rain; the country was laid waste, famine and disease ensued, and in the course of the two succeeding years 1300 people and 150,000 sheep and horses perished. The scene of horror was closed by a dreadful earthquake. Previous to the explosion an ominous mildness of temperature indicated the approach of the volcanic fire towards the surface of the earth: similar warnings had been observed before in the eruptions of Hekla.

A semicircle of volcanic mountains, on the eastern side of the lake Myvatr, is the focus of the igneous phenomena at the northern end of the great central valley. Leirhnukr and Krabla, on the N.E. of the lake, have been especially formidable. After years of quiescence they suddenly burst into violent eruption, and poured such a quantity of lava into the lake Myvatr, which is 20 miles in circumference, that the water boiled many days. There are other volcanoes in this district no less formidable. Various caldrons of boiling mineral pitch, the shattered craters of ancient volcanoes, occur at the base of this semicircle of mountains, and also on the flanks of Mount Krabla. These caldrons throw up jets of the dark matter, enveloped in clouds of steam, at regular intervals, with a loud explosion.

The eruptive boiling springs of Iceland are perhaps the most extraordinary phenomenon in this singular country. All the great aqueous eruptions occur in the trachytic formation: they are characterized by their high temperature, by holding siliceous matter in solution, which they deposit in the form of siliceous sinter, and by the discharge of sulphuretted hydrogen gas. Numerous instances of spouting springs occur at the extremities of the great central valley, especially at its southern end, where more than fifty have been counted in the space of a few acres—some constant,



others periodical, some merely agitated, or stagnant. The Great Geyser and Stokr, six miles north-west from Hekla, are the most magnificent; at regular intervals they project large columns of boiling water 100 feet high, enveloped in clouds of steam, with tremendous noise. Some springs emit gas only, or gas with a small quantity of water. Such fountains are not confined to the land, or fields of ice; they occur also in the sea, and many issue from crevices in the lava-bed of the lake Myvatr, and rise in jets above the surface of the water.

A region of the same character with the mountains of the Icelandic desert extends due west from it to the extremity of the long narrow promontory of the Sneefield Syssel, ending in the snow-clad cone of the Sneefield Jokul, 5000 feet high, one of the most conspicuous mountains in Iceland.

With the exception of the purely volcanic districts described, trap-rocks cover 20,000 square miles of Iceland, in beds perfectly parallel, and almost horizontal, which have been formed by streams of lava at very ancient epochs, spread over the country occasionally 4000 feet deep.

The dismal coasts are torn in every direction by fiords penetrating many miles into the interior, and splitting into endless branches. In these fissures the sea is still, dark, and deep between walls of rock 1000 feet high. The fiords, however, do not here, as in Greenland, terminate in glaciers, but are prolonged in narrow valleys through which streams and rivers run to the sea. In these valleys the inhabitants have their abode, or in meadows which have a transient verdure along some of the fiords, where the sea is so deep that ships find safe anchorage.

In the valleys on the northern coast, near as they approach to the Arctic circle, the soil is wonderfully good, and there is more vegetation than in any other part of Iceland, with the exception of the eastern shore, which is the most favoured portion of this desolate land. Rivers abounding in fish are much more frequent there than elsewhere; willows and juniper adorn the valleys, and birch-trees 20 feet high grow in the vale of Lagerflest, the only place which produces them large enough for house building, and the verdure is fine on the banks of those streams which are heated by volcanic fires.

The climate of Iceland is much less rigorous than that of



Greenland, and it would be still milder were not the air chilled by the immense fields of ice from the Polar Sea which beset its shores.

The inhabitants are supplied with fuel by the Gulf Stream, which brings drift wood in great quantity from Mexico, the Carolinas, Virginia, the river St. Lawrence, some even from the Pacific Ocean is drifted by currents round by the northern shores of Siberia. The mean temperature in the south of the island is about  $39^{\circ}$  of Fahrenheit, that of the central districts  $36^{\circ}$ , and in the north it is rarely above the freezing point. The cold is most intense when the sky is clear, but that is a rare occurrence, as the wind from the sea covers mountain and valley with thick fog. Hurricanes are frequent and furious, and, although thunder is seldom heard in high latitudes, Iceland is an exception, for tremendous thunder-storms are not uncommon there—a circumstance no doubt owing to the volcanic nature of that island, as lightning accompanies volcanic eruptions everywhere. The sun is always above the horizon in the middle of summer, and under it in mid-winter, yet there is no absolute darkness.

The island of Jan Mayen lies nearly midway between Iceland and Spitzbergen: it is the most northern volcanic country known. Its principal feature is the volcano of Beerenberg, 6870 feet high, flanked by enormous glaciers, whose lofty snow-capped cone, apparently inaccessible, has been seen to emit fire and smoke.

The south polar lands are equally volcanic, and as deeply icebound, as those to the north. Victoria Land, which from its extent seems to form part of a continent, was discovered by Sir James Ross, who commanded the expedition sent by the British Government in 1839 to ascertain the position of the south magnetic pole. The extensive tract lies under the meridian of New Zealand; Cape North, its most northern point, is situate in  $70^{\circ} 31'$  S. lat., and  $165^{\circ} 28'$  E. long. To the west of that cape the northern coast of this new land terminates in perpendicular ice-cliffs from 200 to 500 feet high, stretching as far as the eye can reach, with a chain of grounded icebergs extending for miles from the base of the cliffs, all of tabular form, and varying in size from one to nine or ten miles in circumference. A lofty range of peaked mountains rises in the interior at Cape North, covered with unbroken snow, only relieved from uniform whiteness by



shadows produced by the undulations of the surface. The indentations of the coast are filled with ice many hundreds of feet thick, which makes it impossible to land. To the east of Cape North the coast trends first to S.E. by E., and then in a southerly direction to  $78\frac{1}{4}^{\circ}$  of south latitude, at which point it suddenly bends to the east and extends in one continuous vertical ice-cliff to an unknown distance in that direction. The first view of Victoria Land is described as most magnificent. "On the 11th of January, 1841, in about latitude  $71^{\circ}$  S., and longitude  $171^{\circ}$  E., the Antarctic continent was first seen, the general outline of which at once indicated its volcanic character, rising steeply from the ocean in a stupendous mountain-range, peak above peak, enveloped in perpetual snow, and clustered together in countless groups resembling a vast mass of crystallization, which, as the sun's rays were reflected on it, exhibited a scene of such unequalled magnificence and splendour as would baffle all power of language to portray or give the faintest conception of. One very remarkable peak, in shape like a huge crystal of quartz, rose to the height of 7867 feet, another to 9096, and a third to 8444 feet above the level of the sea. From these peaks ridges descended to the coast, terminating abruptly in bold capes, and promontories, whose steep escarpments, affording shelter to neither ice nor snow, alone showed the jet black lava or basalt which reposed beneath the mantle of eternal frost." . . . "On the 28th, in latitude  $77^{\circ} 31'$ , and longitude  $167^{\circ} 1'$ , the burning volcano, Mount Erebus, was discovered covered with ice and snow from its base to its summit, from which a dense column of black smoke towered high above the numerous other lofty cones and crateriferous peaks with which this extraordinary land is studded from the 72d to the 78th degree of latitude. Its height above the sea is 12,367 feet; and Mount Terror, an extinct crater adjoining it, which has doubtless once given vent to fires beneath, attains an altitude little inferior, being 10,884 feet in height, and ending in a cape from which a vast barrier of ice extended in an easterly direction, checking all farther progress south. This continuous perpendicular wall of ice, varying in height from 200 to 100 feet, its summit presenting an almost unvarying level outline, we traced for 300 miles, when the pack-ice obstructed all farther progress."\*

\* Remarks on the Antarctic Continent and Southern Islands, by Robert M'Cormick, Esq., Surgeon of H.M.S. Erebus.



The vertical cliff in question forms a completely solid mass of ice about 1000 feet thick : the greater part of which is below the surface of the sea ; there is not the smallest appearance of a fissure throughout its whole extent ; and the intensely blue sky beyond, indicated plainly the great distance to which the ice-plains reach southwards. Gigantic icicles hang from every projecting point of the icy cliff, showing that it sometimes thaws in these latitudes, although in the month of February, which corresponds with August in England, Fahrenheit's thermometer did not rise above  $14^{\circ}$  at noon. In the North Polar Ocean, on the contrary, streams of water flow from every iceberg during summer. The whole of this country is beyond the pale of vegetation : no moss, not even a lichen, covers the barren soil, where everlasting winter reigns. Parry Mountains, a lofty range stretching south from Mount Terror to the 79th parallel, is the most southerly land yet discovered. The south magnetic pole, the object of the expedition, is situated in Victoria Land, in  $75^{\circ} 5' \text{ S. lat.}$ , and  $154^{\circ} 8' \text{ E. long.}$

Various tracts of land have been discovered near the Antarctic circle, and within it, though none in so high a latitude as Victoria Land ; whether they form part of one large continent remains to be ascertained. Discovery ships, which have been sent by the Russian, French, and American Governments, have increased our knowledge of these far regions, and the spirited adventures of British merchants and captains of whalers have contributed quite as much.

The land within the Arctic circle is generally volcanic, at least the coast-line, which is all that is yet known, and, being covered with snow and ice, it is destitute of vegetation.

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## CHAPTER XIV.

THE CONTINENT OF AUSTRALIA—TASMANIA, OR VAN DIEMEN'S LAND—NEW ZEALAND—NEW GUINEA—BORNEO—ATOLLS—ENCIRCLING REEFS—BARRIER REEFS—CORAL REEFS—VOLCANIC ISLANDS—AREAS OF SUBSIDENCE AND ELEVATION IN THE BED OF THE PACIFIC—ACTIVE VOLCANOES.

THE labyrinth of islands that is scattered over the Pacific Ocean for more than 30 degrees on each side of the equator



and from the 130th eastern meridian to Sumatra, which all but unites this enormous archipelago to the continent of Asia, has the group of New Zealand or Tasmania, and the continent of Australia, with its appendage, Van Diemen's Land, on the south; and altogether forms a region which, from the unstable nature of the surface of the earth, is partly the wreck of a continent that has been engulfed by the ocean, and partly the highest summits of a new one rising above the waves. This extensive portion of the globe is, in many parts, terra incognita; the Indian Archipelago has never been explored, and, with the exception of our colonies in New Holland and New Zealand, is little known.

The continent of New Holland, 2400 miles from east to west, and 1700 from north to south, is divided into two unequal parts by the tropic of Capricorn, and consequently has both a temperate and a tropical climate. New Guinea, separated from New Holland by Torres Straits, and traversed by the same chain of mountains with New Holland and Van Diemen's Land, is so perfectly similar in structure, that it forms but a detached member of the adjacent continent.

The coasts of New Holland are indented by very large bays, and by harbours that might give shelter to all the navies in Europe. The most distinguishing feature of the eastern side, which is chiefly occupied by the British colony of New South Wales, is a long chain of mountains which never goes far from the coast, and, with the exception of some short deviations in its southern part, maintains a meridional direction through  $35^{\circ}$  of latitude. It is continued at one extremity from Torres Straits, and at the north end of the Gulf of Carpentaria, far into the interior of New Guinea; and at the other it traverses the whole of Van Diemen's Land. It is low in the northern parts of New Holland, being in some places merely a high land; but about the 30th degree of south latitude it assumes the form of a regular mountain-chain, and, running in a very tortuous line from N.E. to S.W., terminates its visible course at Wilson's Promontory, the southern extremity of the continent. It is continued, however, by a chain of mountainous islands across Bass's Straits to Cape Portland, in Van Diemen's Land; and from thence the range proceeds in a zigzag line of high and picturesque mountains to South Cape, where it ends, having, in its course



of 1500 miles, separated the drainage of both countries into eastern and western waters.

The distance of the chain from the sea in New South Wales is from 50 to 100 miles, but at the 32d parallel it recedes to 150, yet soon returns, and forms the wild group of the Corecudgy peaks, from whence, under the names of the Blue Mountains and Australian Alps, its highest part, it proceeds in a general westerly direction to the land's ends.

The average height of these mountains is only from 2400 to 4700 feet above the level of the sea, and even Mount Kosciuszko, the loftiest of the Australian Alps, is not more than 6500 feet high, yet its position is so favourable, that the view from its snowy and craggy top sweeps over 7000 square miles. The rugged and savage character of these mountains far exceeds what might be expected from their height: in some places, it is true, their tops are rounded and covered with forest; but by far the greater part of the chain, though wooded along the flanks, is crowned by naked needles, tooth-formed peaks, and flat crests of granite or porphyry, mingled with patches of snow. The spurs give a terrific character to these mountains, and in many places render them altogether inaccessible, both in New South Wales and Van Diemen's Land. These shoot right and left from the ridgy axis of the main range, equal to it in height, and separated from it, and from one another, by dark and almost subterraneous gullies, like rents in the bosom of the earth, iron-bound by impracticable precipices, with streams flowing through them in black silent eddies or foaming torrents. The intricate character of these ravines, the danger of descending into them, and the difficulty of getting out again, render this mountain-chain, in New South Wales at least, almost a complete barrier between the country on the coast and that in the interior—a circumstance very unfavourable to the latter.\*

In New South Wales the country slopes westward from these mountains to a low, flat, unbroken plain. On the east side, darkly verdant and round-topped hills and ridges are promiscuously grouped together, leading to a richly-wooded undulating country, which gradually descends to the coast, and forms the valuable lands of the British colony. Discovered by Cook in the year 1770, it was not colonized till

\* Memoirs of Count Strzelecki.



1778. It has become a prosperous country ; and although new settlers in the more remote parts suffer the privations and difficulties incident to their position, yet there is educated society in the towns, with the comforts and luxuries of civilized life.

The coast-belt on the western side of New Holland is generally of inferior land, with richer tracts interspersed near the rivers ; and bounded on the east by a range of primary mountains from 3000 to 4000 feet high, in which granite occasionally appears. Beyond this the country is level, and the land better, though nowhere very productive except in grass.

None of the rivers of New Holland are navigable to any great distance from their mouths ; the want of water is severely felt in the interior, which, as far as it is known, is a treeless desert of sand, swamps, and jungle ; yet a belief prevails that there is a large sea, or fresh-water lake, in its centre ; and this opinion is founded partly on the nature of the soil, and also because all the rivers that flow into the sea on the northern coast, between the gulfs of Van Diemen and Carpentaria, converge towards their sources, as if they served for drains to some large body of water.

However unpropitious the middle of the continent may be, and the shores generally have the same barren character, there is abundance of fine country inland from the coasts. On the north all tropical productions might be raised, and in so large a continent there must be extensive tracts of arable land, though its peculiar character is pastoral. There are large forests on the mountains and elsewhere, yet that moisture is wanting which clothes other countries in the same latitudes with rank vegetation. In the colonies the clearing of a great extent of land has increased the mean annual temperature, so that the climate has become hotter and drier, and not thereby improved.

Van Diemen's Land, of triangular form, has an area of 27,200 square miles, and is very mountainous. No country has a greater number of deep commodious harbours ; and as most of the rivers, though not navigable to any distance, end in arms of the sea, they afford secure anchorage for ships of any size. The mountain-chain that traverses the colony of New South Wales, and the islands in Bass's Straits, starts anew from Cape Portland, and, winding through Van Die-



men's Land in the form of the letter Z, separates it into two nearly equal parts, with a mean height of 3750 feet, and at an average distance of 40 miles from the sea. It incloses the basins of the Derwent and Heron rivers, and, after sending a branch between them to Hobart Town, ends at South Cape. The offsets which shoot in all directions are as savage and full of impassable chasms as it is itself. There are cultivable plains and valleys along the numerous rivers and large lakes by which the country is well watered; so that Van Diemen's Land is more agricultural and fertile than the adjacent continent, but its climate is wet and cold. The uncleared soil of both countries, however, is far inferior to that in the greater part of North or South America.\*

Granite constitutes the entire floor of the western portion of New South Wales, and extends far into the interior of the continent, bearing a striking resemblance in character to a similar portion of the Altaï chain described by Baron Humboldt. The central axis of the mountain-range, in New South Wales and in Van Diemen's Land, is of granite, syenite, and quartz; but in early times there had been great invasions of volcanic substances, as many parts of the main chain, and most of its offsets, are of the older igneous rocks. The fossiliferous strata of the two colonies are mostly of the Palæozoic period, but their fossil fauna is poor in species. Some are identical with, and others are representatives of, the species of other countries, even of England. It appears, from their coal-measures, that the flora of these countries was as distinct in appearance from that of the northern hemisphere, previous to the carboniferous period, as it is at the present day.

New Zealand, divided into three islands by rocky and dangerous channels, is superior to Australia in richness of soil, fertility, and beauty, and abounds in fine timber and a variety of vegetable and mineral productions. High mountains run through the islands, which in the most northerly rise 14,000 feet above the stormy ocean around, buried two-thirds of their height in permanent snow and glaciers, and exhibiting on the grandest scale all the Alpine characters, with the addition of active volcanoes on the eastern and western coasts. The coast is a broken country, overspread

\* Count Strzelecki.



with a most luxuriant, but dark and gloomy vegetation. There are undulating tracts and table-lands of great extent without a tree, overrun by ferns and a low kind of myrtle; but the mountain-ridges are clothed with dense and gigantic forests. There is much good land and many lakes, with navigable rivers and the best of harbours; so that this country is peculiarly well suited for a colony, but difficult of access from a boisterous ocean.

A very different scene from the stormy seas of New Zealand presents itself to the north of Australia. There, vivified by the glowing sun of the equator, the islands of the Indian Archipelago are of matchless beauty, crowned by lofty mountains, loaded with aromatic verdure, that shelve to the shore, or dip into a transparent glassy sea. Their coasts are cut by deep inlets, and watered by the purest streams, which descend in cascades, rushing through wild crevices. The whole is so densely covered with palms and other beautiful forms of tropical vegetation, that they seem to realize a terrestrial paradise.

Papua, or New Guinea, is the largest island in the Pacific, 1400 miles long, and 200 in width, with mountains rising above mountains, till in the west they attain the height of 16,000 feet, capped with snow, and two volcanoes burn on its northern shores. From its position so near the equator, it is probable that New Guinea has the same vegetation with the Spice Islands to the east; and, from the little that is known of it, must be one of the finest countries in existence.

Borneo, next in size to New Guinea, is a noble island, divided in two by the equator, and traversed through its whole length by magnificent chains of mountains, which end in three branches at the Java Sea. Beautiful rivers flow from them to the plains, and several of these spring from a spacious lake on the table-land in the interior, among the peaks of Keni-Balu, the highest point of the island. Diamonds, gold, and antimony are among its minerals; gums, precious woods, and all kinds of spices and tropical fruit, are among its vegetables.

A volume might be written on the beauty and riches of the Indian Archipelago. Many of the islands are hardly known, and the interior of the greater number has never been explored; so that they offer a wide field of discovery



to the enterprising traveller, and they are now of easier access since the seas have been cleared of pirates by the Honorable Captain Keppel. The success of Mr. Brook in conciliating the natives is a noble instance of the power of mind.

They have become of much importance since our relation with China has been altered, and on that account Captain Stanley, and other scientific naval officers, have been employed to survey the coasts and channels of these unknown seas. The great intertropical islands in the Pacific, likewise other large islands, as Ceylon and Madagascar in the Indian Seas, which, by the way, do not differ in character from the preceding, are really continents in miniature, with their mountains and plains, their lakes and rivers; and in climate they vary, like the main land, with the latitude, only that continental climates are more extreme both as to heat and cold.

It is a singular circumstance, arising from the instability of the crust of the earth, that, with only three or four exceptions, all the smaller tropical islands in the Pacific and Indian Oceans are either volcanic or coralline, except New Caledonia and the Seychelles; and it is a startling fact, that, in most cases where there are volcanoes, the land is rising by slow and almost imperceptible degrees above the ocean, whereas there is every reason to believe that those vast spaces, studded with coral islands or atolls, are actually sinking below it, and have been for ages.\*

There are four different kinds of coral formations in the Pacific and Indian Oceans, all entirely produced by the growth of organic beings and their detritus; namely, lagoon islands or atolls, encircling reefs, barrier reefs, and coral fringes. They are all nearly confined to the tropical regions; the atolls to the Pacific and Indian Oceans alone.

An atoll, or lagoon island, consists of a chaplet or ring of coral, inclosing a lagoon, or portion of the ocean, in its centre. The average breadth of the part of the ring above the surface of the sea is about a quarter of a mile, oftener less, and it seldom rises higher than from 6 to 10 or 12 feet above the waves. Hence the lagoon islands are not discernible at a very small distance, unless when they are covered with the

\* Darwin on Coral Reefs.



cocoa-nut, palm, or the pandana, which is frequently the case. On the outer side this ring or circlet shelves down to the distance of 100 or 200 yards from its edge, so that the sea gradually deepens to 25 fathoms, beyond which the sides plunge at once into the unfathomable depths of the ocean, with a more rapid descent than the cone of any volcano. Even at the small distance of some hundred yards, no bottom has been found with a sounding-line a mile and a half long. All the coral at a moderate depth below water is alive—all above is dead, being the detritus of the living part washed up by the surf, which is so tremendous on the windward side of the tropical islands of the Pacific and Indian Oceans that it is often heard miles off, and is frequently the first warning to seamen of their approach to an atoll.

On the lagoon side, where the water is calm, the bounding-ring, or reef, shelves into it by a succession of ledges, also of living coral, though not of the same species with those which build the exterior wall and the foundations of the whole ring. The perpetual change of water brought into contact with the external coral by the breakers probably supplies them with more food than they could obtain in a quieter sea, which may account for their more luxuriant growth. At the same time, they deprive the whole of the corals in the interior of the most nourishing part of their food, because the still-water in the lagoon, being supplied from the exterior by openings in the ring, ceases to produce the hardier corals; and species of more delicate forms, and of much slower growth, take their place.\* The depth of the lagoon varies, in different atolls, from 20 to 50 fathoms, the bottom being partly detritus and partly live coral. By the growth of the coral, some few of the lagoons have been filled up; but the process is very slow from the causes assigned, and also because there are marine animals that feed on the living coral, and prevent its indefinite growth. In all departments of nature, the exuberant increase of any one class is checked and limited by others. The coral is of the most varied and delicate structure, and of the most beautiful tints. Dark brown, vivid green, rich purple, pink, deep blue, peach-colour, yellow, with dazzling white, con-

\* Supplement to the Observations on the Temple of Seraphis, by Charles Babbage, Esq.



trasted with deep shadows, shine through the limpid water ; while fish of the most gorgeous hues swim among the branching coral, which are of many different kinds, though all combine in the structure of these singular islands. Lagoon islands are sometimes circular, but more frequently oval or irregular in their form. Sometimes they are solitary, or in groups, but they occur most frequently in elongated archipelagos, with the atolls elongated in the same direction. The grouping of atolls bears a perfect analogy to the grouping of the archipelagos of ordinary islands.

The size of atolls varies from two to ninety miles in diameter, and islets are frequently formed on the coral rings by the washing up of the detritus, for they are so low that the waves break over them in high tides or storms. They have openings or channels in their circuit, generally on the lee side, where the tide enters, and by these ships may sail into the lagoons, which are excellent harbours ; and even on the surface of the circlet or reef itself there are occasionally boat-channels, between the islets.

Dangerous Archipelago, lying east of the Society Islands, is one of the most remarkable assemblages of atolls in the Pacific Ocean. There are 80 of them, generally of a circular form, surrounding very deep lagoons, and separated from each other by profound depths. The reefs or rings are about half a mile wide, and seldom rise more than 10 feet above the edge of the surf, which beats on them with such violence that it may be heard at the distance of 8 miles ; and yet on that side the coral insects build more vigorously, and vegetation thrives better, than on the other : many of the islets are inhabited.

The Caroline Archipelago, the largest of all, lies north of the equator, and extends its atolls in 60 groups over 1000 miles. Many are of great size, and all are beat by a tempestuous sea and occasional hurricanes. The atolls in the Pacific Ocean and China Sea are beyond enumeration. Though less frequent in the Indian Ocean, none are more interesting, or afford more perfect specimens of this peculiar formation or the Maldiva and Laccadive Archipelagos, both nearly parallel to the coast of Malabar, and elongated in that direction. The former is 470 miles long, and about 50 miles broad, with the atolls arranged in a double row, separated by an unfathomable sea, into which their sides descend



with more than ordinary rapidity. The largest atoll is 88 miles long, and somewhat less than 20 broad ; Suadiva, the next in size, is 44 miles by 23, with a large lagoon in its centre, to which there is access by 42 openings. There are inhabited islets on most of the chaplets or rings not higher than 20 feet, while the reefs themselves are nowhere more than 6 feet above the surge.

The Laccadives run to the north of this archipelago in a double line of nearly circular atolls, on which are low inhabited islets.

Encircling reefs differ in no respect from atoll reefs except that they have one or more islands in their lagoon. They commonly form a ring round mountainous islands, at a distance of two or three miles from the shore, rising on the outside from a very deep ocean, and separated from the land by a lagoon or channel 200 or 300 feet deep. These reefs surround the submarine base of the island, and, rising by a steep ascent to the surface, they encircle the island itself. The Caroline Archipelago, already mentioned, exhibits good examples of this structure in the encircled islands of Hogolen and Seniavine : the narrow ring or encircling reef of the former is 135 miles in its very irregular circuit, on which are a vast number of islets ; but six or eight islands rise to considerable height from its lagoon, which is so deep, and the opening into it so large, that a frigate might sail into it. The encircling reef of Seniavine is narrow and irregular, and its lagoon is so nearly filled by a lofty island, that it leaves only a strip of water round it from two to five miles wide and 30 fathoms deep.

Otaheite, the largest of the Society group, is another instance of an encircled island of the most beautiful kind ; it rises in mountains 7000 feet high, with only a narrow plain along the shore, and, except where cleared for cultivation, it is covered with forests of cocoa-nut, palms, bananas, bread-fruit, and other productions of a tropical climate. The lagoon, which encompasses it like an enormous moat, is 30 fathoms deep, and is hemmed in from the ocean by a coral band of the usual kind, at a distance varying from half a mile to three miles.

Barrier reefs are of precisely the same structure as the two preceding classes, from which they only differ in their position with regard to the land. A barrier reef off the north-



east coast of the continent of Australia is the grandest coral formation existing. Rising at once from an unfathomable ocean, it extends 1000 miles along the coast, with a breadth varying from 200 yards to a mile, and at an average distance of from 20 to 30 miles from the shore, in some places increasing to 60 and even 70 miles. The great arm of the sea included between it and the land is nowhere less than 10, occasionally 60 fathoms deep, and is safely navigable throughout its whole length, with a few transverse openings, by which ships can enter. The reef is really 1200 miles long, because it stretches nearly across Torres Straits. There are also extensive barrier reefs on the islands of Louisiade and New Caledonia, which are exactly opposite to the great Australian reef; and as atolls stud that part of the Pacific which lies between them, it is called the Coralline Sea. The rolling of the billows along the great Australian reef has been admirably described. "The long ocean-swell, being suddenly impeded by this barrier, lifted itself in one great continuous ridge of deep blue water, which, curling over, fell on the edge of the reef in an unbroken cataract of dazzling white foam. Each line of breaker runs often one or two miles in length with not a perceptible gap in its continuity. There was a simple grandeur and display of power and beauty in this scene that rose even to sublimity. The unbroken roar of the surf, with its regular pulsation of thunder, as each succeeding swell fell first on the outer edge of the reef, was almost deafening, yet so deep-toned as not to interfere with the slightest nearer and sharper sound. . . . Both the sound and sight were such as to impress the spectator with the consciousness of standing in the presence of an overwhelming majesty and power."\*

Coral reefs are distinct from all the foregoing: they are merely fringes of coral along the margin of a shore, and, as they line the shore itself, they have no lagoons. A vast extent of coast, both on the continents and islands, are fringed by these reefs, and, as they frequently surround shoals, they are very dangerous.

Lagoon islands are the work of various species of coral insects, but those particular polypi which build the profound external wall, the foundation and support of the whole ring

\* By Mr. Jukes, Naturalist to the Surveying Voyage of Captain Blackwood, R.N., in Torres Straits.



or reef, are most vigorous when most exposed to the breakers: they cannot exist at a greater depth than 25 or 30 fathoms at most, and die immediately when left dry; yet the coral wall descends precipitously to unfathomable depths; and although the whole of it is not the work of these insects, yet the perpendicular thickness of the coral is known to be very great, extending hundreds of feet below the depth at which these polypi cease to live. From an extensive survey of the Coralline seas of the tropics, Mr. Darwin has found an explanation of these singular phenomena in the instability of the crust of the earth.

Since there are certain proofs that large areas of the dry land are gradually rising, and others sinking down, so the bottom of the ocean is not exempt from the general change that is slowly bringing about a new state of things; and as there is evidence on multitudes of the volcanic islands in the Pacific of a rise in certain parts of the basis of the ocean, so the lagoon islands indicate a subsidence in others—changes arising from the expansion and contraction of the strata under the bed of the ocean.

There are strong reasons for believing that a continent once occupied a great part of the tropical Pacific, some part of which subsided by slow and imperceptible degrees. As portions of it gradually sank down below the surface of the deep, the tops of mountains and table-lands would remain as islands of different magnitude and elevation, and would form archipelagos elongated in the direction of the mountain-chains. Now the coral-insect which constructs the outward wall and mass of the reefs, never builds laterally, and cannot exist at a greater depth than 25 or 30 fathoms. Hence, if it began to lay the foundations of its reef on the submerged flanks of an island, it would be obliged to build its wall upwards in proportion as the island sank down, so that at length a lagoon would be formed between it and the land. As the subsidence continued, the lagoon would increase, the island would diminish, and the base of the coral reef would sink deeper and deeper, while the insects would always keep its top just below the surface of the ocean, till at length the island would entirely disappear, and a perfect atoll would be left. If the island were mountainous, each peak would form a separate island in the lagoon, and the encircled islands would have different forms, which the



reefs would follow continuously. This theory perfectly explains the appearances of the lagoon islands and barrier reefs, the continuity of the reef, the islands in the middle of the lagoons, the different distances of the reefs from them, and the forms of the archipelago so exactly similar to the archipelagos of ordinary islands, all of which are but the tops of submerged mountain-chains, and generally partake of their elongated forms.

Every intermediate form between an atoll and an encircling reef exists; New Caledonia is a link between them. A reef runs along the north-western coast of that island 400 miles, and for many leagues never approaches within 8 miles of its shore, and the distance increases to 16 miles near the southern extremity. At the other end the reefs are continued on each side 150 miles beyond the submarine prolongation of the land marking the former extent of the island. In the lagoon of Keeling Atoll, situate in the Indian Ocean 600 miles south of Sumatra, many fallen trees and a ruined store-house show that it has subsided: these movements take place during the earthquakes at Sumatra, which are also felt in this atoll. Violent earthquakes have lately been felt at Vanikora, a lofty island with an encircling reef in the western part of the South Pacific, and on which there are marks of recent subsidence. Other proofs are not wanting of this great movement in the beds of the Pacific and Indian Oceans.

The extent of the atoll formations, including under this name encircling reefs, is enormous. In the Pacific, from the southern end of Low Archipelago to the northern end of Marshall Archipelago, a distance of 4500 miles, and many degrees of latitude in breadth, there is not an island that is not of atoll formation. The same may be said of the space in the Indian Ocean between Saya de Matha and the end of the Laccadives, which includes 25 degrees of latitude—such are the enormous areas that have been, and probably still are, slowly subsiding. Other spaces of great extent may also be mentioned—as the large archipelago of the Carolinās, that in the Coralline Sea off the north-west coast of Australia, and an extensive one in the China Sea.

Though the volcanic islands in the Pacific are so numerous, there is not one within the areas mentioned, and there is not an active volcano within several hundred miles of an



archipelago, or even group of atolls. This is the more interesting, as recent shells and fringes of dead coral, found at various heights on their surfaces, show that the volcanic islands have been rising more and more above the surface of the ocean for a very long time.

The volcanic islands also occupy particular zones in the Pacific, and it is found from extensive observation that all the points of eruption fall on the areas of elevation.

One of the most terribly active of these zones begins with the Banda group of islands, and includes Timor, Sumbawa, Bali, Java, and Sumatra, separated only by narrow channels, and altogether forming a gently curved line 2000 miles long; but as the volcanic zone is continued through Barren Island, in the Bay of Bengal, northward to an island off the Birmah coast, the entire length of this volcanic range is a great deal more.

The little island of Gounong-API, belonging to the Banda group, contains a volcano of great activity; and such is the elevating pressure of the submarine fire in that part of the ocean, that a mass of black basalt rose up of such magnitude as to fill a bay 60 fathoms deep so quietly that the inhabitants were not aware of what was going on till it was nearly done. Timor and the other adjacent islands also bear marks of recent elevation.

There is not a spot of its size on the face of the earth that contains so many volcanoes as the island of Java.\* A range of volcanic mountains, from 5000 to 13,000 feet high, forms the central crest of the island, and ends to the east in a series of 38 separate volcanoes with broad bases rising gradually into cones. They all stand on a plain but little elevated above the sea, and each individual mountain seems to have been formed independently of the rest. Most of them are of great antiquity, and are covered with thick vegetation. Some are extinct or only emit smoke; from others sulphureous vapours issue with prodigious violence; one has a large crater filled with boiling water; and a few have had fierce eruptions of late years. The island is covered with volcanic spurs from the main ridge, united by cross chains, together with other chains of less magnitude but no less fury.

\* Sir Stamford Raffles on Java.



In 1772 the greater part of one of the largest volcanic mountains was swallowed up after a short but severe combustion: a luminous cloud enveloped the mountain on the 11th of August, and soon after the huge mass actually disappeared under the earth with tremendous noise, carrying with it about 90 square miles of the surrounding country, 40 villages, and 2957 of their inhabitants.

The northern coast of Java is flat and swampy, but the southern provinces are beautiful and romantic; yet in the lovely peaceful valleys the stillness of night is disturbed by the deep roaring of the volcanoes, many of which are perpetually burning with slow but terrific action.

Separated by narrow channels of the sea, Bali and Sumbawa are but a continuation of Java, the same in nature and structure, but on a smaller scale, their mountains being little more than 8000 feet high.

The intensity of the volcanic force under this part of the Pacific may be imagined from the eruption of Tomboro in Sumbawa in 1815, which continued from the 5th of April till July: the explosions were heard at the distance of 970 miles; and in Java, at the distance of 300 miles, the darkness during the day was like that of deep midnight. The country around was ruined, and the town of Tomboro was submerged by heavy rollers from the ocean.

In Sumatra the extensive granitic formations of eastern Asia join the volcanic series which occupies so large a portion of the Pacific. This most beautiful of islands presents the boldest aspect: it is indented by arms of the most transparent sea, and watered by innumerable streams; it displays in its vegetation all the bright colouring of the tropics. Here the submarine fire finds vent in three volcanoes on the southern, and one on the northern side of the island. A few atolls, many hundreds of miles to the south, show that this volcanic zone alternates with an area of subsidence.

More to the north, and nearly parallel to the preceding zone, another line of volcanic islands begins to the north of New Guinea, and passes through New Britain, New Ireland, Solomon's Islands, and the New Hebrides, containing many open vents. This range, or area of elevation, separates the Coralline Sea from the great chain of atolls on the north between Ellice's group and the Caroline Islands, so that it lies between two areas of subsidence.



The third and greatest of all the zones of volcanic islands begins at the northern extremity of Celebes, and includes Gilolo, one of the Molucco group, which is bristled with volcanic cones; and from thence it may be traced northwards through the Philippine Islands and Formosa: bending thence to the north-east, it passes through Loo Choo, the Japan Archipelago, and is continued by the Kurile Islands to the peninsula of Kamtschatka, where there are several active volcanoes of great elevation.

The Philippine Islands and Formosa form the volcanic separation between the atoll region in the China Sea and that of the Caroline and Pellew groups.

There are six islands east of Jephoon, in the Japan Archipelago, which are subject to eruptions, and the internal fire breaks through the Kurile Islands in 18 vents, besides having raised two new islands in the beginning of this century, one four miles round and the other 3000 feet high, though the ocean there is so deep that the bottom has not been reached with a line 200 fathoms long.

Thus some long rent in the earth had reached from the tropics to the gelid seas of Okhotsk, probably connected with the peninsula of Kamtschatka: a new one begins to the east of the latter in the Aleutian Islands, which are of the most barren and desolate aspect, perpetually beaten by the surge of a restless ocean, and bristled by the cones of 24 volcanoes; they sweep in a half-moon round Behring's Sea till they join the volcanic peninsula of Russian America.

The line of volcanic agency has been followed far beyond the limits of the coral working insects, which extend but a short way on each side of the tropics; but it has been shown that, in the equatorial regions, immense areas of elevation alternate with as great areas of subsidence; north of New Holland they are so mixed that it indicates a point of convergence.\*

On the other side of the Pacific the whole chain of the Andes, and the adjacent islands of Juan Fernandez and the Galapagos, form a vast volcanic area, which is actually now rising. And though there are few volcanic islands north of the zone of atolls, yet those that be indicate great

\* Darwin on Volcanic Islands.



internal activity, especially the Sandwich Islands, where the volcanoes of Owhyhee are inferior to none in awful sublimity.

It may be observed that, where there are coral fringes, the land is either rising or stationary; for, were it subsiding, lagoons would be formed. On the contrary, there are many fringing reefs on the shores of volcanic islands along the coasts of the Red Sea, the Persian Gulf, and the West Indian islands, all of which are rising. Indeed, this occurrence, in numberless instances, coincides with the existence of upraised organic remains on the land.

As the only coral formations in the Atlantic are fringing reefs, the bed of that ocean is not sinking; and, with the exception of the Leeward Islands, the Canaries, and Cape de Verde groups, there are no active volcanoes on the islands or on the coasts of that ocean. The Peak of Teneriffe is a splendid instance.

At present the great continent has few centres of volcanic action in comparison with what it once had. The Mediterranean is still undermined by fire, which occasionally finds vent in Vesuvius and the stately cone of Etna. Though Stromboli constantly pours forth an inexhaustible stream of lava, and a temporary island now and then starts up from the sea, the volcanic action is diminished, and Italy has become comparatively more tranquil.

The table-land of western Asia, especially Azerbaijan, had once been the seat of intense commotion, now spent, or only smoking from the snowy cone of Demavend. The table-land of eastern Asia furnishes the solitary instance of igneous explosion at a distance from the sea in the volcanic chain of the Thean-Tchan.

The seat of activity has been perpetually changing. There always has been volcanic action, possibly more intense in former times, but even at present it extends from pole to pole.

Notwithstanding the numerous volcanic vents in the globe, many places are subject to violent earthquakes, which ruin the works of man, and often change the configuration of the country.

Earthquakes are produced by fractures and sudden heavings and subsidences in the elastic crust of the globe, from the pressure of the liquid fire, vapour, and gases in its inte-



rior, which there find vent, relieve the tension which the strata acquire during their slow refrigeration, and restore equilibrium. But whether the initial impulse be eruptive, or a sudden pressure upwards, the shock originating in that point is propagated through the elastic surface of the earth in a series of circular or oval undulations, similar to those produced by dropping a stone into a pool, and like them they become broader and lower as the distance increases, till they gradually subside : in this manner the shock travels through the land, becoming weaker and weaker till it terminates. When the impulse begins in the interior of a continent, the elastic wave is propagated through the solid crust of the earth, as well as in sound through the air, and is transmitted from the former to the ocean, where it is finally spent and lost, or, if very powerful, is continued in the opposite land. Almost all the great earthquakes however have their origin in the bed of the ocean, far from land, whence the shocks travel in undulations to the surrounding shores.

No doubt many of small intensity are imperceptible ; it is only the violent efforts of the internal forces, that can overcome the pressure of the ocean's bed, and that of the superincumbent water. The internal pressure is supposed to find relief most readily in a belt of great breadth that surrounds the land at a considerable distance from the coast, and, being formed of its débris, the internal temperature is in a perpetual state of fluctuation, which would seem to give rise to sudden flexures and submarine eruptions.

When the original impulse is a fracture or eruption of lava in the bed of the deep ocean, two kinds of waves or undulations are produced and propagated simultaneously—one through the bed of the ocean, which is the true earthquake shock : and coincident with this a wave is formed and propagated on the surface of the ocean, which rolls to the shore, and reaches it in time to complete the destruction long after the shock or wave through the solid ocean-bed has arrived and spent itself on the land. The height to which the surface of the ground is elevated, or the vertical height of the shock-wave, varies from one inch to two or three feet. This earth-wave, on passing under deep water, is imperceptible, but when it comes to soundings it carries with it to the land a long flat aqueous wave : on arriving at



the beach the water drops in arrear from the superior velocity of the shock, so that at that moment the sea seems to recede before the great ocean-wave arrives.

It is the small forced wave that gives the shock to ships, and not the great wave; but when ships are struck in very deep water, the centre of disturbance is either immediately under, or very nearly under, the vessel.

Three other series of undulations are formed simultaneously with the preceding, by which the sound of the explosion is conveyed through the earth, the ocean, and the air, with different velocities. That through the earth travels at the rate of from 7000 to 10,000 feet in a second in hard rock, and somewhat less in looser materials, and arrives at the coast a short time before, or at the same moment with the shock, and produces the hollow sounds that are the harbingers of ruin; then follows a continuous succession of sounds, like the rolling of distant thunder, formed, first, by the wave that is propagated through the water of the sea, which travels at the rate of 4700 feet in a second; and, lastly, by that passing through the air, which only takes place when the origin of the earthquake is a submarine explosion, and travels with a velocity of 1123 feet in a second. The rolling sounds precede the arrival of the great wave on the coasts, and are continued after the terrific catastrophe when the eruption is extensive.

When there is a succession of shocks all the phenomena are repeated.

The velocity of the great oceanic wave varies as the square root of the depth; it consequently has a rapid progress through deep water, and less when it comes to soundings. The velocity of the shock varies with the elasticity of the strata it passes through. The undulations of the earth are subject to the same laws as those of light and sound; hence when the shock or earth-wave passes through strata of different elasticity, it will partly be reflected, and a wave will be sent back, producing a shock in a contrary direction, and partly refracted, or its course changed; so that shocks will occur both upwards and downwards, to the right or to the left of the original line of transit. Hence most damage is done at the junction of deep alluvial plains with the hard strata of the mountains, as in the great earthquake in Calabria in the year 1783.



When the height of the undulations is small, the earthquake will be a horizontal motion, which is the least destructive ; when the height is great, the vertical and horizontal motions are combined, and the effect is terrible ; but the worst of all is a verticose or twisting motion, which nothing can resist. It is occasioned by the crossing of two waves of horizontal vibration, which unite at their point of intersection and form a rotatory movement. This, and the interferences of shocks arriving at the same point from different origins or routes of different length, account for the repose in some places, and those extraordinary phenomena that took place during the earthquake of 1783, in Calabria, where the shock diverged on all sides from a centre through a highly elastic base covered with alluvial soil, which was tossed about in every direction. The dynamics of earthquakes are ably discussed by Mr. Mallet in a very interesting paper in the Transactions of the Royal Irish Academy.

There are few places where the earth is long at rest ; for, independently of those secular elevations and subsidences that are in progress over such extensive tracts of country, small earthquake shocks must be much more frequent than we imagine, though imperceptible to our senses, and only to be detected by means of instruments. The shock of an earthquake at Lyons in February, 1822, was not generally perceptible at Paris, yet the wave reached and passed under that city, and was detected by the swinging of the large declination needle at the Observatory, which had previously been at rest. Even in Scotland 139 slight shocks have been registered within a few years, of which 81 occurred at Comrie, in Perthshire, but the cause is at no great depth under the surface, as the shocks extended to a small distance.

The undulations of some of the great earthquakes have spread to an enormous extent : that which destroyed Lisbon had its origin immediately under the devoted city, from whence the shock extended over an area of about 700,000 square miles, or a twelfth part of the circumference of the globe : the West Indian islands, and the lakes in Scotland, Norway, and Sweden, were agitated by it. It began without warning, and in five minutes the city was a heap of ruins.

The earthquake of 1783, in Calabria, which completely changed the face of the country, lasted only two minutes,



but it was not very extensive. Baron Humboldt's works are full of interesting details on the subject, especially with regard to the tremendous convulsions in South America.

Sometimes a shock has been carried underground which was not felt at the surface, as in the year 1802, in the silver mine of Marienberg, in the Hartz. In some instances miners have been insensible to shocks felt on the surface above, which happened at Fahlun, in Sweden, in 1823—circumstances depending, in both instances, on the elasticity of the strata, the depth of the impulses, or obstacles that may have changed the course of the terrestrial undulation. During earthquakes, dislocations of strata take place, the course of rivers is changed, and in some instances they have been permanently dried up, rocks are hurled down, masses raised up, and the configuration of the country altered; but if there be no fracture at the point of original impulse, there will be no noise.

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## CHAPTER XV.

THE OCEAN—ITS SIZE, COLOUR, PRESSURE, AND SALTNESS—  
TIDES, WAVES, AND CURRENTS—TEMPERATURE—NORTH  
AND SOUTH POLAR ICE—INLAND SEAS.

THE ocean, which fills a deep cavity in the globe and covers three-fourths of its surface, is so unequally distributed that there is three times more land in the northern than in the southern hemisphere. The torrid zone is chiefly occupied by sea, and only one twenty-seventh part of the land on one side of the earth has land opposite to it on the other. The form assumed by this immense mass of water is that of a spheroid flattened at the poles; and as its mean level is always nearly the same, for any thing we know to the contrary, it serves as a base for measuring the height of the land.

The bed of the ocean, like that of the land, of which it is the continuation, is diversified by plains and mountains, table-lands and valleys, sometimes barren, sometimes covered with marine vegetation, and teeming with life. Now it sinks into depths, which the sounding-line has never



fathomed, now it appears in chains of island, or rises near to the surface in hidden reefs and shoals, perilous to the mariner. Springs of fresh water rise from the bottom, volcanoes eject their lavas and scoriæ, and earthquakes trouble the deep waters.

The ocean is continually receiving the spoils of the land, and from that cause would constantly be decreasing in depth, and, as the quantity of water is always the same, its superficial extent would increase: there are however counter-acting causes to check this tendency; the secular elevation of the land over extensive tracts, in many parts of the world, is one of the most important.\* Volcanoes, coral islands, and barrier reefs show that great changes of level are constantly taking place in the bed of the ocean itself,—that symmetrical bands of subsidence and elevation extend alternately over an area equal to a hemisphere, from which it may be concluded that the balance is always maintained between the sea and land, although the distribution may vary in the lapse of time.

The Pacific or Great Ocean exceeds in superficies all the dry land on the globe. It has an area of 50,000,000 square miles: including the Indian Ocean its area is nearly 70,000,000. Its breadth from Peru to the coast of Africa is 16,000 miles: it is shorter than the Atlantic, as it only communicates with the Arctic Ocean by Behring's Strait, whereas the Atlantic, as far as we know, stretches from pole to pole.

The continent of Australia occupies a comparatively small portion of the Pacific, while innumerable islands stud its surface many degrees on either side of the equator, of which a great number are volcanic, showing that its bed has been, and indeed actually is, the theatre of violent igneous eruptions. So great is its depth that a line five miles long has not reached the bottom in many places. Between the tropics it is generally unfathomable; yet, as the whole mass of the ocean counts for little in the total amount of terrestrial gravitation, its mean depth is but a small fraction of the radius of the globe.

The bed of the Atlantic is a long deep valley with few mountains, or at least but few that raise their summits in

\* Darwin on Coral Reefs.



islands above its surface. Its greatest breadth, including the Gulf of Mexico, is 5000 miles, and its superficial extent is about 25,000,000 square miles. This sea is exceedingly deep. In  $27^{\circ} 26'$  S. lat. and  $17^{\circ} 29'$  W. long. Sir James Ross found the depth to be 14,550 feet; 450 miles west from the Cape of Good Hope it was 16,062 feet, or 332 feet more than the height of Mont Blanc; and in  $15^{\circ} 3'$  S. lat. and  $23^{\circ} 14'$  W. long. a line of 27,600 feet did not reach the bottom, which is equal to the height of some of the most elevated peaks of the Himalaya, but there is reason to believe that many parts of the ocean are still deeper. A great part of the German Ocean is only 93 feet deep, though on the Norwegian side, where the coast is bold, the depth is 910 fathoms.

Immense sand-banks often project from the land, which rise from great depths to within a few fathoms of the surface. Of these the Aghullus Bank, at the Cape of Good Hope, is one of the most remarkable: that off Newfoundland is still greater; it consists of a double bank, which is supposed to reach to the north of Scotland. The Dogger Bank, in the North Sea, and many others, are well known: some on the coast of Norway are surrounded by such deep water that they must be submarine table-lands. All are the resort of fish.

The pressure at great depths is enormous. In the Arctic Ocean, where the specific gravity of the water is least, on account of the melting of the ice, the pressure at the depth of a mile and a quarter is 2809 pounds on a square inch of surface: this was confirmed by Captain Scoresby, who says, in his "Arctic Voyages," that the wood of a boat suddenly dragged to a great depth by a whale, was found when drawn up so saturated with water forced into its pores, that it sank in water like a stone for a year afterwards: even sea-water is reduced in bulk from 20 to 19 solid inches at the depth of 20 fathoms. The compression that a whale can endure is wonderful. All fish are capable of sustaining great pressures as well as sudden changes of pressure. Divers in the pearl-fisheries exert great muscular strength; but man cannot bear the increased pressure at great depths, because his lungs are full of air, nor can he endure the diminution of it at great altitudes above the earth.

The depth to which the sun's light penetrates the ocean



depends upon the transparency of the water, and cannot be less than twice the depth to which a person can see from the surface. In parts of the Arctic Ocean shells are distinctly seen at the depth of 80 fathoms; and among the West India islands, in 30 fathoms water, the bed of the sea is as clear as if seen in air: shells, corals, and sea-weeds of every hue display the tints of the rainbow.

The purest spring is not more limpid than the water of the ocean: it absorbs all the prismatic colours except that of ultramarine, which, being reflected in every direction, imparts a hue approaching the azure of the sky. The colour of the sea varies with every gleam of sunshine or passing cloud, although its true tint is always the same when seen sheltered from atmospheric influence. The reflection of a boat on the shady side is often of the clearest blue, while the surface of the water exposed to the sun is bright as burnished gold. The waters of the ocean also derive their colour from insects of the infusorial kind, vegetable substances, and minute particles of matter. It is white in the Gulf of Guinea, black round the Maldives; at California the Vermilion Sea is so called on account of the red colours of the infusoria it contains: the same red colour was observed by Magellan at the mouth of the River Plata. The Persian Gulf is called the Green Sea by eastern geographers, and there is a tract of green water off the Arabian coast so distinct that a ship has been seen in green and blue water at the same time. Rapid transitions take place in the Arctic Sea from ultramarine to olive-green, from purity to opacity. These appearances are not delusive, but constant as to place and colour: the green is produced by myriads of minute insects, which devour one another, and are a prey to the whale. The colour of clear shallow water depends upon that of its bed; over chalk or white sand it is apple-green, over yellow sand dark green, brown or black over dark ground, and grey over mud.

The sea is supposed to have acquired its saline principle when the globe was in the act of subsiding from a gaseous state. The density of sea-water depends upon the quantity of saline matter it contains: the proportion is generally about three or four per cent., though it varies in different places; the ocean contains more salt in the southern than in the northern hemisphere, the Atlantic more than the Pacific. The greatest proportion of salt in the Pacific is in the paral-



lels of  $22^{\circ}$  N. lat. and  $17^{\circ}$  S. lat. : near the equator it is less ; and in the Polar Seas it is least, from the melting of the ice. The saltness varies with the seasons in these regions, and the fresh water, being lighter, is uppermost. Rain makes the surface of the sea fresher than the interior parts, and the influx of rivers renders the ocean less salt at their estuaries : the Atlantic is brackish 300 miles from the mouth of the Amazons. Deep seas are more saline than those that are shallow, and inland seas communicating with the main are less salt, from the rivers that flow into them : to this however the Mediterranean is an exception, occasioned by the great evaporation and the influx of salt currents from the Black Sea and the Atlantic. The water in the Straits of Gibraltar, at the depth of 670 fathoms, is four times as salt as that at the surface.

Fresh water freezes at the temperature of  $32^{\circ}$  of Fahrenheit ; the point of congelation of salt water is lower. As the specific gravity of the water of the Greenland Sea is about 1.02664, it does not freeze till its temperature is reduced to  $28\frac{1}{2}^{\circ}$  of Fahrenheit ; so that the saline principle preserves the sea in a liquid state to a much higher latitude than if it had been fresh, while it is better suited for navigation by its greater buoyancy. The healthfulness of the sea is ascribed to the mixing of the water by tides and currents, which prevents the accumulation of putrescent matter.

Raised by the moon and modified by the sun in the equatorial seas, the central area of the two oceans is occupied by a great tidal wave, which oscillates continually, keeping time with the returns of the moon, having its motion kept up by her attraction acting at each return. The height of these oceanic tides depends upon the relative position of the sun and moon, and upon their declination and distances from the earth. From the skirts of this oscillating central area, partial tides diverge in all directions, whose velocity depends upon the depth and local circumstances of the sea : these derivative tides are so much influenced by the form of the shore along which they travel that they become of great magnitude in the higher latitudes, while near the centre of the oscillating area the oceanic tide is often very small. The spring-tides rise 50 or 60 feet on some parts of the British coast : in the Bay of Fundy, in Nova Scotia, they rise 60 feet ; at St. Helena they never exceed three feet ; and there



is scarcely any tide among many of the tropical islands in the Pacific.

At the equator the tide follows the moon at the rate of 1000 miles an hour; but the derivative tides are so retarded by the form of coasts and irregularities at the bottom of the sea, that a tide is sometimes impeded by an obstacle till a second tide reaches the same point by a different course, and the water rises to double the height it would otherwise have attained: a complete extinction of the tide takes place when a high-water interferes in the same manner with a low-water, as in the centre of the German Ocean; and when two unequal tides of contrary phases of rise and fall meet, the greater overpowers the lesser, and the resulting height is equal to their difference: such varieties occur chiefly among islands, and at the estuaries of rivers. When the tide flows suddenly up a river, it checks the descent of the stream, so that a high wave, called a bore, is driven with force up the channel. This sometimes occurs in the Ganges; and in the Amazons, at the equinoxes, during three successive days, five of these destructive waves, from 12 to 15 feet high, follow one another up the river daily. In the Turury Channel, in Cayenne, the sea rises 40 feet in five minutes, and as suddenly ebbs.

There may be some small flow of the water westward with the oceanic tide under the equator, though it is imperceptible; but that does not necessarily follow, since the tide in the open ocean is merely an alternate rise and fall of the surface, so that the *motion*, not the water, follows the moon. A bird resting on the sea is not carried forward as the waves rise and fall: indeed, if so heavy a body as water were to move at the rate of 1000 miles in an hour, it would cause universal destruction, since in the most violent hurricanes the velocity of the wind hardly exceeds 100 miles an hour. Over shallows however, and near the land, the water does advance, and rolls in waves on the beach.

The friction of the wind combines with the tides in agitating the surface of the ocean, and, according to the theory of undulations, each produces its effect independently of the other; wind, however, not only raises waves, but causes a transfer of superficial water also. Attraction between the particles of air and water, as well as the pressure of the atmosphere, brings its lower stratum into adhesive contact with the surface of the sea. If the motion of the wind be parallel



to the surface, there will still be friction, but the water will be smooth as a mirror; but if it be inclined, in however small a degree, a ripple will appear. The friction raises a minute wave, whose elevation protects the water beyond it from the wind, which consequently impinges on the surface at a small angle: thus, each impulse combining with the other produces an undulation which continually advances.

Those beautiful silvery streaks on the surface of a tranquil sea called catspaws by sailors are owing to a partial deviation of the wind from a horizontal direction. The resistance of the water increases with the strength and inclination of the wind. The agitation at first extends little below the surface, but, in long-continued gales, even the deep water is troubled: the billows rise higher and higher; and as the surface of the sea is driven before the wind, their "monstrous heads," impelled beyond the perpendicular, fall in wreaths of foam. Sometimes several waves overtake one another, and form a sublime and awful sea. The highest waves known are those which occur during a north-west gale off the Cape of Good Hope, aptly called the Cape of Storms by ancient Portuguese navigators; and Cape Horn seems to be the abode of the tempest. The sublimity of the scene, united to the threatened danger, naturally leads to an over-estimate of the magnitude of the waves, which appear to rise mountains high, as they are proverbially said to do. There is, however, reason to doubt if the highest waves off the Cape of Good Hope exceed 40 feet from the hollow trough to the summit. They are said to rise 20 feet off Australia, and 16 feet in the Mediterranean. The waves are short and abrupt in small, shallow seas, and on that account are more dangerous than the long rolling billows of the wide ocean.

The undulation called a *ground-swell*, occasioned by the continuance of a heavy gale, is totally different from the tossing of the billows, which are confined to the area vexed by the wind, whereas the ground-swell is rapidly transmitted through the ocean to regions far beyond the direct influence of the gale that raised it; and it continues to heave the smooth and glassy surface of the deep long after the wind and the billows are at rest. A swell frequently comes from a quarter in direct opposition to the wind, and sometimes from various points of the compass at the same time, producing a vast commotion even in a dead calm, without ruffling



the surface. They are the heralds that point out to the mariner the distant region where the tempest has howled, and they are not unfrequently the harbingers of its approach. In addition to the other dangers from polar ice, there is always a swell at its margin.

Heavy swells are propagated through the ocean, till they gradually subside from the friction of the water, or till the undulation is checked by the resistance of land, when they roll in surf to the shore, or dash in spray and foam over rocks. The rollers at the Cape de Verde Islands, are seen at a great distance approaching like mountains. When a gale is added to a ground-swell, the commotion is great, and the force of the surge tremendous, tossing huge masses of rock and shaking the cliffs to their foundation. The violence of the tempest is sometimes so intense as to quell the billows and blow the water out of the sea, driving it in a heavy shower called *spoon-drift* by sailors. On such occasions saline particles have impregnated the air to the distance of 50 miles inland.

The effect of a gale descends to a comparatively small distance below the surface; the sea is probably tranquil at the depth of 200 or 300 feet: were it not so, the water would be turbid and shell-fish would be destroyed. Any thing that diminishes the friction of the wind smooths the surface of the sea: for example, oil, or a small stream of packed ice, which suppresses even a swell. When the air is moist its attraction for water is diminished, and, consequently, so is the friction; hence the sea is not so rough in rainy as in dry weather.

Currents of various extent, magnitude, and velocity disturb the tranquillity of the ocean; some of them depend upon circumstances permanent as the globe itself, others on ever-varying causes. Constant currents are produced by the combined action of the rotation of the earth, the heat of the sun, and the trade winds; periodical currents are occasioned by tides, monsoons, and other periodical winds; temporary currents arise from the tides, melting ice, and from every gale of some duration. A perpetual circulation is kept up in the waters of the main by these vast marine streams. They are sometimes superficial, sometimes submarine, according as their density is greater or less than that of the surrounding sea.



The exchange of water between the poles and the equator gives rise to the great permanent currents in the ocean. Although these depend upon the same causes as the trade winds, they differ essentially in this respect—that, whereas the atmosphere is heated from below by its contact with the earth, and transmits the heat to the strata above, the sea is heated at its surface by the direct rays of the sun, which diminish the specific gravity of the upper strata, especially between the tropics, and also occasion strong and rapid evaporation, both of which causes disturb the equilibrium of the ocean. The rotation of the earth also gives the water a tendency to take an oblique direction in its flow towards the equatorial regions, as, in order to restore the equilibrium, deranged by so many circumstances, great streams perpetually descend from either pole towards the equator. When these currents leave the poles they flow directly north and south; but, before proceeding far, their motion is deflected by the diurnal rotation of the earth. At the poles they have no rotatory motion; and although they gain it more and more by the friction of the water in their progress to the equator, which revolves at the rate of 1000 miles an hour, they arrive at the tropics before they have acquired the same velocity of rotation with the intertropical ocean. On that account they are left behind, and consequently seem to flow in a direction contrary to the diurnal rotation of the earth. For that reason the whole surface of the ocean, for 30 degrees on each side of the equator, has an apparent tendency from east to west, which produces all the effects of a great current or stream flowing in that direction. The trade winds, which blow constantly nearly the same way, combine to give this current a velocity of 9 or 10 miles in 24 hours.

It is evident that the primary currents, as well as those derived from them, must be subject to periodical variations of intensity of six months' duration, because of the melting of the ice at each pole alternately.

The westerly tendency of the equatorial current in the Atlantic is checked by the continent of America, which stretches directly across its course; so that about the 10th parallel of south latitude it is divided by the coast of Brazil into two branches, one of which runs south and the other north-west. The latter rushes along the coast of Brazil with



such force and depth that it is neither deflected by the powerful stream of the river Amazons nor that of the Orinoco. Though much weakened in passing among the West Indian islands, it acquires new strength and the high temperature of  $86^{\circ}$  of Fahrenheit in the Caribbean Sea. From thence, after sweeping round the Gulf of Mexico, it flows through the State of Florida and along the North American coast to Newfoundland: it is there deflected eastward by the diminished velocity of rotation, and also by a current from Baffin's Bay, so that it proceeds to the Azores. From thence it bends southward, and rejoins the equatorial current, having formed a circuit of 3800 miles with various velocity and a breadth of from 50 to 250 miles, leaving a vast loop or space of water nearly stagnant in its centre, which is thickly covered with sea-weed. The bodies of men, animals, and plants of unknown appearance, brought to the Azores by this stream, suggested to Columbus the idea of land beyond the Western Ocean, and thus led to his discovery of America. The Gulf Stream is more salt, warmer, and of a deeper blue than the rest of the ocean, till it reaches Newfoundland, where it becomes turbid from the shallowness of that part of the sea. Its greatest velocity is 78 miles a-day soon after leaving the Florida Strait, and its greatest breadth is 120 miles, though the warm water spreads over the surface of the ocean to a much greater extent. An important branch leaves this current near Newfoundland, setting towards Britain and Norway, which is again subdivided into many branches, whose origin is recognised by their greater warmth, even at the edge of perpetual ice in the Polar Ocean, while they tend in some degree, by their superficial direction, to prevent the ice from spreading over the North Sea; and in consequence of some of these branches the Spitzbergen Sea is  $6^{\circ}$  or  $7^{\circ}$  warmer at the depth of 200 fathoms than it is at the surface. The other branch of the equatorial stream, after setting southward along the coast of Brazil, becomes insensible before reaching the Straits of Magellan.

In the Pacific Ocean a current comes from the south pole along the shores of Chili and Peru to Mexico, having in some seasons a temperature  $24^{\circ}$  below that of the Equatorial Sea. From Mexico, aided by the equatorial current of the Great Ocean, it crosses the Pacific with so strong a stream,



that ships passing from Acapulco to Manilla rarely have occasion to set their sails. Branches flow on each side of Australia, which unite and run through the Bay of Bengal to the extremity of the Indian peninsula ; one part then strikes across the ocean, another and greater flows through the Mozambique Channel : these currents then unite in a stream 100 miles broad, and the greater part, called the Lagullus Current, doubles the Cape of Good Hope, and rushes down the coast of Africa, till it joins the equatorial current of the Atlantic. These oceanic streams exceed all the rivers in the world in breadth and depth, as well as length. The equatorial current in the Atlantic is 160 miles broad off the coast of Africa, but towards its mid-course, across the Atlantic, its width becomes nearly equal to the whole length of Great Britain ; but as it then sends off a branch to the N.W., it is diminished to 200 miles before reaching the coast of Brazil. The depth of this great stream is unknown, but the Brazilian branch must be very profound, since it is not deflected by the river La Plata, which crosses it with so strong a current that its fresh muddy waters are perceptible 500 miles from its mouth. When currents pass over banks and shoals, the colder water rises to the surface, and gives warning of the danger.

The action of these oceanic rivers has been very great on the eastern sides of both continents, where they have scooped out bays and gulfs, and torn off many islands from the land : indeed, the whole earth bears the marks of a great current rushing with violence from the east.

Under-currents are supposed to flow in many places in a direction opposite to the set of the water on the surface, but of these little is known. In summer, the great north polar current coming along the coast of Greenland and Labrador, together with the current from Davis's Straits, brings icebergs to the margin of the Gulf Stream and disappear. Probably from their density they become under-currents which pass to lower latitudes. Counter-currents on the surface are of such frequent occurrence that there is scarcely a strait joining two seas that does not furnish an example—a current running in along one shore, and a counter-current running out along the other.

Periodical currents are frequent in the eastern seas : one flows into the Red Sea from October to May, and out of it



from May to October ; in the Persian Gulf this order is reversed. In the Indian Ocean and China Sea the waters are driven alternately backwards and forwards by the monsoons. It is the south-westerly monsoon that causes inundations in the Ganges and a tremendous surf on the coast of Coromandel. The tides also produce periodical currents on the coasts and in straits, the water running in one direction during the flood, and the contrary way in the ebb. The Roost of Sumbury, at the southern promontory of Zetland, runs at the rate of 15 miles an hour ; indeed the strongest tidal currents known are among the Orkney and Zetland islands ; their great velocity arises from local circumstances. Currents in the wide ocean move at the rate of from one to three miles an hour, and the velocity is less at the margin and bottom of the stream from friction.

Whirlpools are produced by opposing winds and tides : the whirlpool of Maelstrom, on the coast of Norway, is occasioned by the meeting of tidal currents round the islands of Logodon and Maskoe ; it is a mile and a half in diameter, and so violent that its roar is heard at the distance of several leagues.

Although, with winds, tides, and currents, it might seem that the ocean is ever in motion, yet in the equatorial regions, far from land, dead calms prevail ; the sea is of the most perfect stillness day after day, rarely does a shower fall, thunder is almost never heard, and the winds are at rest. The sea partakes of the universal quiet, and heaves its low flat waves in noiseless and regular periods, as if nature were asleep.

Salt water is a bad conductor of heat, therefore the temperature of the ocean is less liable to sudden changes than the atmosphere : the influence of the season is imperceptible at the depth of 300 feet ; and as the light probably does not penetrate lower than 700 feet, the heat of the sun cannot affect the bottom of a deep sea. It has been established beyond a doubt by Kotzebue and Sir James Ross, that throughout the whole of the deep ocean the water has an invariable temperature of about  $39^{\circ} 5'$  of Fahrenheit at a certain depth depending on the latitude. At the equator the stratum of invariable temperature is at the depth of 7200 feet ; from thence it gradually rises till it comes to the surface in S. lat.  $56^{\circ} 26'$ , where the water has the temperature



of  $39^{\circ} 5'$ , at all depths ; it then gradually descends to S. lat.  $70^{\circ}$ , where it is 4500 feet below the surface.

In going north from the equator the same law is observed : hence with regard to temperature there are three regions in the ocean, one equatorial and two polar. In the equatorial region the temperature of the water at the surface of the ocean is  $80^{\circ}$ , therefore higher than that of invariable temperature, while in the polar regions it is lower. Thus the surface of the stratum of constant temperature is a curve which begins at the depth of 4500 feet in the southern basin, from whence it gradually rises to the surface in S. lat.  $56^{\circ} 26'$  ; it then sweeps down to 7200 feet at the equator, and rises up again to the surface in the corresponding northern latitude, from whence it descends again to a depth of 4500 feet in the northern basin. From these circumstances Sir James Ross justly infers that the internal heat of the earth has no influence upon the mean temperature of the ocean. The temperature of the surface of the ocean decreases from the equator to the poles. For ten degrees on each side of the line the maximum is  $80^{\circ}$  of Fahrenheit, and remarkably staple ; from thence the decrease to each tropic does not exceed  $37^{\circ}$ . The tropical temperature would be greater were it not for the currents, because the surface reflects much fewer of the sun's rays, that fall on it directly, than that in higher latitudes, where they fall obliquely. In the torrid zone the surface of the sea is about  $35^{\circ}$  of Fahrenheit warmer than the air above it, because the polar winds, and the great evaporation which absorbs the heat, prevent equilibrium ; and as a great mass of water is slow in following the changes in the atmosphere, the vicissitude of day and night has little influence, whereas in the temperate zones it is perceptible.

The superficial temperature diminishes from the tropics as the latitude increases, more rapidly in the southern than in the northern hemisphere, till towards each pole the sea becomes a solid mass of ice. In the Arctic Ocean the surface is at the freezing point even in summer, and during the eight winter months a continuous body of ice extends in every direction from the pole, filling the area of a circle of between 2000 and 4000 miles in diameter. The outline of this circle, though subject to partial variations, is found to be nearly similar at the same season of each succeeding



year, yet there are periodical changes in the polar ice, which are renewed after a series of years. The freezing process itself is a bar to the unlimited increase of the oceanic ice. Fresh water congeals at the temperature of  $32^{\circ}$  of Fahrenheit, but sea-water must be reduced to  $28^{\circ} 5'$  before it deposits its salt and begins to freeze: the salt thus set free, and the heat given out, retard the process of congelation more and more below.

The ice from the north pole comes so far south in winter as to render the coast of Newfoundland inaccessible: it envelops Greenland, sometimes even Iceland, and always invests Spitzbergen and Nova Zembla. As the sun comes north the ice breaks up into enormous masses of what is called packed ice. It is remarkable that in a fine summer the ice suddenly clears away, and leaves an open channel of sea along the western coast of Spitzbergen from 60 to 150 miles wide, extending to  $80^{\circ}$  or even  $80\frac{1}{2}^{\circ}$  N. lat., probably owing to warm currents from low latitudes. In the year 1806 Captain Scoresby forced his ship through 250 miles of packed ice, in imminent danger, until he reached the parallel of  $81^{\circ} 50'$ , his nearest approach to the pole: the Frozen Ocean is rarely navigable so far.

In the year 1827 Sir Edward Parry arrived at the latitude of  $82^{\circ} 45'$ , which he accomplished by dragging a boat over fields of solid ice, but he was obliged to abandon the bold and hazardous attempt to reach the pole, because the current drifted the ice southward more rapidly than he could travel over it to the north.

Floating fields of ice 20 or 30 miles in diameter are frequent in the Arctic Ocean; sometimes they extend 100 miles, so closely packed together that no opening is left between them; their thickness, which varies from 10 to 40 feet, is not seen, as there is at least two-thirds of the mass below water. Sometimes these fields, many thousand millions of tons in weight, acquire a rotatory motion of great velocity, dashing against one another with a tremendous collision. Packed ice always has a tendency to drift southwards, even in the calmest weather; and in their progress the ice-fields are rent in pieces by the swell of the sea. It is computed that 20,000 square miles of drift ice are annually brought by the current along the coast of Greenland to Cape Farewell. In stormy weather the fields and streams of ice



are covered with haze and spray from constant tremendous concussions ; yet our seamen, undismayed by the appalling danger, boldly steer their ships amidst this hideous and discordant tumult.

Huge icebergs are rolled from the glaciers which extend miles from the arctic lands into the sea, especially in Baffin's Bay, and are drifted southwards 2000 miles from their origin to melt in the Atlantic, where they cool the water sensibly for 40 or 50 miles around, and the air to a much greater distance. They vary from a few yards to miles in circumference, and rise hundreds of feet above the surface. Seven hundred such masses have been seen at once in the polar basin. When there is a swell the loose ice dashing against them raises the spray to their very summits ; and if a large mass falls from them, they occasionally lose their equilibrium and roll over, causing a swell which breaks up the neighbouring field-ice : the commotion then spreads far and wide, and the uproar resounds for miles like thunder.

Icebergs have the appearance of chalk-cliffs with a glittering surface and emerald-green fractures ; pools of water of azure-blue lie on their surface, or fall in cascades into the sea. The field-ice also, and the masses that are heaped up on its surface, are extremely beautiful from the vividness and contrast of their colouring. A peculiar blackness in the atmosphere indicates their position in a fog, and their place and character are shown at night by the reflection of the snow-light on the horizon. An experienced seaman can readily distinguish whether the ice is newly formed, heavy, compact, or open. The blink or snow-light of field-ice is the most lucid, and is tinged yellow ; of packed ice it is pure white : ice newly formed has a greyish blink ; and a deep yellow tint indicates snow on land.

Icebergs come to a lower latitude by  $10^{\circ}$  from the south pole than from the north, and appear to be larger. One observed by Captain d'Urville was 13 miles long, with perpendicular sides 100 feet high. They are less varied than those on the northern seas ; a tabular form is prevalent. The discovery ships under the command of Sir James Ross met with multitudes bounded by perpendicular cliffs on every side with flat surfaces from 100 to 180 feet high, sometimes several miles in circumference. On one occasion they fell in with a chain of stupendous bergs close to one another, ex-



tending farther than the eye could reach even from the mast-head. Packed ice, too, is in immense quantities: these ships forced their way through a pack 1000 miles broad, often under the most appalling circumstances. It generally consists of smaller pieces than the packs in the comparatively tranquil North Polar seas, where they are often several miles in diameter, and where fields of ice extend beyond the extent of vision. The Antarctic Ocean, on the contrary, is almost always agitated; there is a perpetual swell, and terrific storms are common, which break up the ice and render navigation perilous. The pieces are rarely a quarter of a mile in circumference, and generally much smaller.

A more dreadful situation can hardly be imagined than that of ships beset during a tempest in a dense pack of ice in a dark night, thick fog and drifting snow, with the spray beating perpetually over the decks, and freezing instantaneously. Sir James Ross's own words can alone give an idea of the terrors of one of the many gales which the two ships under his command encountered: "Soon after midnight our ships were involved in an ocean of rolling fragments of ice, hard as floating rocks of granite, which were dashed against them by the waves with so much violence, that their masts quivered as if they would fall at every successive blow; and the destruction of the ships seemed inevitable from the tremendous shocks they received. In the early part of the storm the rudder of the 'Erebus' was so much damaged as to be no longer of any use; and about the same time I was informed by signal that the 'Terror's' was completely destroyed, and nearly torn away from the stern-post. Hour passed away after hour without the least mitigation of the awful circumstances in which we were placed. The loud crashing noise of the straining and working of the timber and decks, as they were driven against some of the heavier pieces of ice, which all the exertions of our people could not prevent, was sufficient to fill the stoutest heart, that was not supported by trust in Him who controls all events, with dismay; and I should commit an act of injustice to my companions if I did not express my admiration of their conduct on this trying occasion. Throughout a period of 28 hours, during any one of which there appeared to be very little hope that we should live to see an-



other, the coolness, steady obedience, and untiring exertions of each individual, were every way worthy of British seamen.

“The storm gained its height at 2 P.M., when the barometer stood at 28.40 inches, and after that time began to rise. Although we had been forced many miles deeper into the pack, we could not perceive that the swell had at all subsided, our ships still rolling and groaning amidst the heavy fragments of crushing bergs, over which the ocean rolled its mountainous waves, throwing huge masses one upon another, and then again burying them deep beneath its foaming waters, dashing and grinding them together with fearful violence.”

For three successive years were these dangers encountered during this bold and hazardous enterprise.

The ocean is one mass of water, which, entering into the interior of the continents, has formed seas and gulfs of great magnitude, which afford easy and rapid means of communication, while they temper the climates of the widely expanding continents.

The inland seas communicating with the Atlantic are larger, and penetrate more deeply into the continents, than those connected with the Great Ocean; a circumstance that gives a coast of 48,000 miles to the former, while that of the Great Ocean is only 44,000. Most of these internal seas have extensive river domains, so that by inland navigation the Atlantic virtually enters into the deepest recesses of the land, brings remote regions into contact, and improves the condition of the less cultivated races of mankind by commercial intercourse with those that are more civilised.

The Baltic, which occupies 125,000 square miles in the centre of Northern Europe, is one of the most important of the inland seas connected with the Atlantic; and although inferior to the others in size, the drainage of more than a fifth of Europe flows into it. Only about a fourth part of the boundary of its enormous basin of 900,000 square miles is mountainous; and so many navigable rivers flow into it from the watershed of the great European plain, that its waters are one-fifth less salt than those of the Atlantic: it receives at least 250 streams. Its depth nowhere exceeds 115 fathoms, and generally it is not more than 40 or 50. From that cause, together with its freshness and northern



latitude, the Baltic is frozen five months in the year. From the flatness of the greater part of the adjacent country, the climate of the Baltic is subject to influences coming from regions far beyond the limits of its river-basin. The winds from the Atlantic bring warmth and moisture, which, condensed by the cold blasts from the Arctic plains, falls in rain in summer, and deep snow in winter, which also makes the sea more fresh. The tides are imperceptible; but the waters of the Baltic occasionally rise more than three feet above their usual level from some unknown cause—possibly from oscillations in its bed, or from changes of atmospheric pressure.

The Black Sea, which penetrates most deeply into the continent of all the seas in question, has, together with the Sea of Azow, an area of 190,000 square miles; but it must at a remote period have been united with the Caspian Lake, and must have covered all the steppe of Astracan. It receives some of the largest European rivers, and drains about 950,000 square miles; consequently its waters are brackish, and freeze on its northern shores in winter.

Of all the branches of the Atlantic that enter deeply into the bosom of the land, the Mediterranean is the most beautiful and the largest, covering with its dark blue waters more than 760,000 square miles. Situate in a comparatively low latitude, exposed to the heat of the African deserts on the south, and sheltered on the north by the Alps, the evaporation is excessive. Its temperature is  $10^{\circ}$  or  $12^{\circ}$  higher than that of the Atlantic. Although its own river domain is only 250,000 square miles, the constant current that sets into it through the Dardanelles brings a great part of the drainage of the Black Sea, so that it is really fed by the melted snow and rivers from the Caucasus, Asia Minor, Abyssinia, the Atlas, and the Alps. Yet the quantity of water that flows into the Mediterranean from the Atlantic by the central current in the Straits of Gibraltar exceeds that which goes out by the lateral ones. In consequence of the excessive evaporation, the water of the Mediterranean is four times as salt as that of the ocean.

The Mediterranean is divided into two basins by a shallow that runs from Cape Bon on the African coast to the Strait of Messina, on each side of which the water is exceedingly deep, and said to be unfathomable in some parts.



This sea is not absolutely without tides; in the Gulf of Venice they rise to three feet, and at the Great Syrte to five at new and full moon; but in most other places they are scarcely perceptible. The surface is traversed by various currents; two of which, opposing one another, occasion the celebrated whirlpool of Charybdis, whose terrors were much diminished by the earthquake of 1783. Its bed is subject to violent volcanic paroxysms; and its surface is studded with islands of all sizes, from the magnificent kingdom of Sicily to mere barren rocks; some actively volcanic, others of volcanic formation, and many of the secondary geological period.

Various parts of its coasts are in a state of great instability; in some places they have sunk down and risen again more than once within historical record.

Far to the north the Atlantic penetrates the American continent by Davis's Straits, and spreads out into Baffin's Bay, twice the size of the Baltic, very deep, and subject to all the rigours of an arctic winter—the very storehouse of Icebergs, the abode of the walrus and whale. Hudson's Bay, though without the Arctic circle, is but little less dreary.

Very different is the character of those vast seas where the Atlantic comes “cranking in” between the northern and southern continents of America. The surface of the sea in Baffin's Bay is seldom above the freezing point; here, on the contrary, it is always  $89^{\circ}$  of Fahrenheit; while the Atlantic Ocean, in the same latitude, is not above  $77^{\circ}$  or  $78^{\circ}$ . Of that huge mass of water partially separated from the Atlantic by a long line of islands and banks, the Caribbean Sea is the largest. It is as long from east to west as the distance between Great Britain and Newfoundland, and occupies a million of square miles. Its depth is very great in many places, and its water limpid. The Gulf of Mexico, fed by the Mississippi, one of the greatest of rivers, is more than half its size, or about 625,000 square miles, so that the whole forms a sea of great magnitude. Its shores, and the shores of the numerous islands, are dangerous from shoals and coral reefs; but the interior of these seas is not. The trade winds prevail there; they are subject to severe northern gales; and some parts are occasionally visited by tremendous hurricanes.

The Pacific does not penetrate the land in the same manner that the Atlantic does the continent of Europe. The



Red Sea and Persian Gulf are joined to it by very narrow straits; but almost all the internal seas on the eastern coast of Asia, except the Yellow Sea, are great gulfs shut in by islands, like the Caribbean Sea and the Gulf of Mexico: to which the China Sea (the 'Toung-Hai'), the Sea of Japan, and that of Okhotsk, are perfectly analogous.

The set of the great oceanic currents has scooped out and indented the southern and eastern coasts of the Asiatic continent into enormous bays and gulfs, and has separated large portions of the land, which now remain as islands—a process which probably has been increased by the submarine fires extending along the eastern coast from the equator nearly to the Arctic circle.

The perpetual motion of the ocean by winds, tides, and currents, is continually but slowly changing the form and position of the land—steadily producing those vicissitudes on the surface of the earth to which it has been subject for ages, and to which it will assuredly be liable in all time to come.

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## CHAPTER XVI.

SPRINGS—BASINS OF THE OCEAN—ORIGIN, COURSE, AND FLOODS OF RIVERS—HYDRAULIC SYSTEMS OF EUROPE—AFRICAN RIVERS; THE NILE, NIGER, ETC.

THE vapour which rises invisibly from the land and water ascends in the atmosphere till it is condensed by the cold into clouds, which restore it again to the earth in the form of rain, hail, and snow: hence there is probably not a drop of water on the globe that has not been borne on the wings of the wind. Part of this moisture restored to the earth is reabsorbed by the air, part supplies the wants of animal and vegetable life, a portion is carried off by streams, and the remaining part percolates through porous soils till it arrives at a stratum impervious to water, where it accumulates in subterranean lakes often of great extent. The mountains receive the greatest portion of the aerial moisture, and, from the many alternations of permeable and impermeable strata they contain, a complete system of reservoirs is formed in



them, which, continually overflowing, form perennial springs at different elevations, that unite and run down their sides in incipient rivers. A great portion of the water at these high levels penetrates the earth till it comes to an impermeable stratum below the plains, where it collects in a sheet, and is forced by hydrostatic pressure to rise in springs through cracks in the ground to the surface. In this manner the water which falls on hills and mountains is carried through highly inclined strata to great depths, and even below the bed of the ocean, in many parts of which there are springs of fresh water. In boring artesian wells the water often rushes up with such impetuosity by the hydrostatic pressure as to form jets 40 or 50 feet high. In this operation several successive reservoirs have been met with: at St. Ouen, in France, five sheets of water were found; the water in the four first not being good, the operation was continued to a greater depth. It consists merely in boring a hole of small diameter, and lining it with a tube. It rarely happens that water may not be procured in this way; and as the substratum in many parts of deserts is an argillaceous marl, it is probable that artesian wells might be bored with success.

A spring will be intermittent when it issues from an opening in the side of a reservoir fed from above if the supply be not equal to the waste, for the water will sink below the opening, and the spring will stop till the reservoir is replenished. Few springs give the same quantity of water at all times; they also vary much in the quantity of foreign matter they contain. Mountain springs are generally very pure; the carbonic acid gas almost always found in them goes into the atmosphere, and their earthy matter is deposited as they run along, so that river-water from such sources is soft, while wells and springs in the plains are hard and more or less mineral.

The water of springs takes its temperature from that of the strata through which it passes. Mountain springs are cold, but, if the water has penetrated deep into the earth, it acquires a temperature depending on that circumstance.

The temperature of the surface of the earth varies with the seasons to a certain depth, where it becomes permanent and equal to the mean annual temperature of the air above. It is evident that the depth at which this stratum of invariable temperature lies must vary with the latitude. At the equator



the effect of the seasons is imperceptible at the depth of a foot below the surface ; between the parallels of  $40^{\circ}$  and  $52^{\circ}$  the temperature of the ground in Europe is constant at the depth of from 55 to 60 feet ; and in the high Arctic regions the soil is perpetually frozen a foot below the surface. Now, in every part of the world where experiments have been made, the temperature of the earth increases with the depth below the constant stratum at the rate of  $1^{\circ}$  of Fahrenheit for every 50 or 60 feet of perpendicular depth : hence, should the increase continue to follow the same ratio, even granite must be in fusion at little more than five miles below the surface. In Siberia the stratum of frozen earth is some hundred feet thick, but below that the increase of heat with the depth is three times as rapid as in Europe. The temperature of springs must therefore depend on the depth to which the water has penetrated before it has been forced to the surface either by the hydraulic pressure of water at higher levels or by steam. If it never goes below the stratum of invariable temperature, the heat of the spring will vary with the seasons more or less according to the depth below the surface ; should the water come from the constant stratum itself, its temperature will be invariable ; and if from below it, the heat will be in proportion to the depth to which it has penetrated. Thus there may be hot and even boiling springs hundreds of miles distant from volcanic action and volcanic strata, of which there are many examples, though they are more frequent in volcanic countries and those subject to earthquakes. The temperature of hot springs is very constant, and that of boiling springs has remained unchanged for ages : shocks of earthquakes sometimes affect their temperature, and have even stopped them altogether. Jets of steam of high tension are frequent in volcanic countries, as in Iceland.

Both hot and cold water dissolves and combines with many of the mineral substances it meets with in the earth, and comes to the surface from great depths as medicinal springs, containing various ingredients. So numerous are they that in the Austrian dominions alone there are 1500, and few countries of any extent are destitute of them. They contain sulphuric and carbonic acids, sulphur, iron, magnesia, and other matters. Boiling springs deposit silex, as in Iceland, Italy, and in the Azores ; and others of lower temperature deposit carbonate and sulphate of lime in enormous quanti-



ties all over the world. Springs of pure brine are very rare; those in Cheshire are rich in salt, and have flowed unchanged 1000 years, a proof of the tranquil state of that part of the globe. Many substances that lie beyond our reach are brought to the surface by springs, as naphtha, petroleum, and borax; petroleum is particularly abundant in Persia, and numberless springs and lakes of it surround some parts of the Caspian Sea. It is found in immense quantities in various parts of the world.

## RIVERS.

Rivers have had a greater influence in the location and fortunes of the human race than almost any other physical cause; and since their velocity has been overcome by steam navigation, they have become the highway of the nations.

They frequently rise in lakes which they unite with the sea; in other instances they spring from small elevations in the plains, from perennial sources in the mountains, alpine lakes, melted snow, and glaciers, but the everlasting store-houses of the mightiest floods are the ice-clad mountains of table-land.

Rivers are constantly increased, in descending the mountains and traversing the plains, by tributaries, till at last they flow into the ocean, their ultimate destination and remote origin. "All rivers run into the sea, yet the sea is not full," because it gives in evaporation an equivalent for what it receives.

The Atlantic, the Arctic, and the Pacific Oceans, are directly or indirectly the recipients of all the rivers, therefore their basins are bounded by the principal watersheds of the continents: for the basin of a sea or ocean does not mean only the bed actually occupied by the water, but comprehends also all the land drained by the rivers which fall into it, and is bounded by an imaginary line passing through all their sources. These lines generally run through the elevated parts of a country that divide the streams which flow in one direction from those that flow in another. But the watershed does not coincide in all cases with mountain-crests of great elevation, as the mere convexity of a plain is often sufficient to throw the streams into different directions.



None of the European rivers flowing directly into the Atlantic exceed the 4th or 5th magnitude, except the Rhine; the rest of the principal streams come to it indirectly through the Baltic, the Black Sea, and the Mediterranean. It nevertheless drains nearly half of the old continent, and almost all the new, because the Andes and Rocky Mountains, which form the watershed of the American continent, lie along its western side, and the rivers which rise on the western slope of the Alleghanies are tributaries to the Mississippi, which comes indirectly into the Atlantic by the Gulf of Mexico.

The Arctic Ocean drains the high northern latitudes of America, and receives those magnificent Siberian rivers, that originate in the Altaï range from the steppe of the Kerghis to the extremity of Kamtschatka, as well as the very inferior streams of North European Russia. The running waters of the rest of the world merge in the Pacific. The Caspian and Lake of Aral are mere lakes, which receive rivers but emit none.

Mountain-torrents gradually lose velocity in their descent to the low lands by friction, and when they enter the plains their course becomes still more gentle, their beds smoother, and their depth greater. A slope of one foot in 200 prevents a river from being navigable, and a greater inclination forms a rapid or a cataract. The speed, however, does not depend upon the slope alone, but also upon the height of the source of the river, and the pressure of the body of water in the upper part of its course; consequently, under the same circumstances, large rivers run faster than small, but in each individual stream the velocity is perpetually varying with the form of the banks, the winding of the course, and the changes in the width of the channel. The Rhone, one of the most rapid European rivers, has a declivity of one foot in 2620, and flows at the rate of 120 feet in a minute; the sluggish rivers in Flanders have only half that velocity. The Danube, the Tigris, and Indus are among the most rapid of the large rivers.

When one river falls into another, the depth and velocity are increased, but not always proportionally to the width of the channel, which sometimes even becomes less, as at the junction of the Ohio with the Mississippi. When the angle of junction is very obtuse, and the velocity of the tributary



stream great, it sometimes forces the water of its primary to recede a short distance. The Arve, swollen by a freshet, occasionally drives the water of the Rhone back into the Lake of Geneva; and it once happened that the force was so great as to make the mill-wheels revolve in a contrary direction.

Instances have occurred of rivers suddenly stopping in their course for some hours, and leaving their channels dry. On the 26th of November, 1838, the water failed so completely in the Clyde, Nith, and Tiviot, that the mills were stopped eight hours in the lower part of their streams. The cause was the coincidence of a gale of wind and a strong frost, which congealed the water near their sources. Exactly the contrary happens in the Siberian rivers, which flow from south to north over so many hundreds of miles; the upper parts are thawed, while the lower are still frozen, and the water, not finding an outlet, inundates the country.

The alluvial soil carried down by streams is gradually deposited as their velocity diminishes; and if they are subject to inundations, and the coast flat, it forms deltas at their mouths. There they generally divide into two branches, which often join again, or are united by transverse channels, so that a labyrinth of streams and islands is formed. Deltas are sometimes found in the interior of the continents, at the junction of rivers, exactly similar to those on the ocean, though less extensive.

Tides flow up rivers to a great distance, and to a height far above the level of the sea. The tide is perceptible in the river of the Amazons 576 miles from its mouth, and it ascends 255 miles in the Orinoco.

In the temperate zones rivers are subject to floods from autumnal rains and the melting of the snow, especially on mountain-ranges. The Po, for example, spreads desolation far and wide over the plains of Lombardy; but these torrents are as variable in their recurrence and extent as the climate which produces them. The inundations of the rivers in the torrid zone, on the contrary, occur with that regularity peculiar to a region in which meteoric phenomena are uniform in all their changes. These floods are due to the periodical rains which, in tropical countries, follow the cessation of the trade-winds after the equinox of spring and at the turn of the monsoons, and are thus dependent on the



declination of the sun, the immediate cause of all these variations. The melting of the snow, no doubt, adds greatly to the floods of the tropical rivers which rise in the high mountain-chains, but it is only an accessory circumstance; for although the snow-water from the Himalaya swells the streams considerably before the rains begin, yet the principal effect is owing to the latter, as the southern face of the Himalaya is not beyond the influence of the monsoon, and the consequent periodical rains, which besides prevail all over the plains of India traversed by the great rivers and their tributaries.

Under like circumstances, the floods of rivers, whose sources have the same tropical latitude, take place at the same season; but the periods of the inundations of rivers on one side of the equator are exactly the contrary of what they are in rivers on the other side of it, on account of the declination of the sun. The flood in the Orinoco is at its greatest height in the month of August, while that of the river of the Amazons, south of the equinoctial line, is at its greatest elevation in March.\* The commencement and end of the annual inundations in each river depend upon the mean time of the beginning, and on the duration of the rains in the latitudes traversed by its affluents. The periods of the floods of such rivers as run towards the equator are different from those flowing in an opposite direction; and as the swell requires time to travel, it happens at regular but different periods in various parts of the same river, if very long. The height to which the water rises in the annual floods depends upon the nature of the country, but it is wonderfully constant in each individual river where the course is long; for the inequalities in the quantity of rain in a district drained by any of its affluents is imperceptible in the general flood, and thus the quantity of water carried down is a measure of the mean humidity of the whole country comprised in its basin from year to year. By the admirable arrangement of these periodical inundations, the fresh soil of the mountains, borne down by the water, enriches countries, far remote from their source. The Mountains of the Moon, and of Abyssinia, have fertilized the banks of the Nile through a distance of 2500 miles for thousands of years.

\* Baron Humboldt's Personal Narrative.



When rivers rise in mountains, water communication between them in the upper parts of their course is impossible; but when they descend to the plains, or rise in the low lands, the boundaries between the countries drained by them become low, and the different systems may be united by canals. It sometimes happens, in extensive and very level plains, that the tributaries of the principal streams either unite or are connected by a natural canal, by which a communication is formed between the two basins—a circumstance advantageous to the navigation and commerce of both, especially where the junction takes place far inland, as in the Orinoco and Amazons, in the interior of South America. The Rio Negro, one of the largest affluents of the latter, is united to the Upper Orinoco, in the plains of Esmeralda, by the Cassiquiare—a stream as large as the Rhine, with a velocity of 12 feet in a second. Baron Humboldt observes that the Orinoco sending a branch to the Amazons is, with regard to distance, as if the Rhine should send one to the Seine or Loire. At some future period this junction will be of great importance. These bifurcations are frequent in the deltas of rivers, but very rare in the interior of continents. The Mahomuddy and Gadavery, in Hindostan, seem to have something of the kind, and there are several instances in the great rivers of the Indo-Chinese peninsula.

The hydraulic system of Europe is eminently favourable to inland navigation, small as the rivers are in comparison with those in other parts of the world; but the flatness of the great plain, and the lowness of its watershed, are very favourable to the construction of canals. In the west, however, the Alps and German mountains divide the waters that flow to the Atlantic on one side, and to the Mediterranean and the Black Sea on the other; but in the eastern parts of Europe the division of the waters is merely a more elevated ridge of the plain itself, for in all plains such undulations exist, though often imperceptible to the eye. This watershed begins on the northern declivity of the Carpathian Mountains, about the 23d meridian, on a low range of hills running between the sources of the Dnieper and the tributaries of the Vistula, from whence it winds in a tortuous course along the plain to the Valday table-land, which is its highest point, 1200 feet above the sea. It then declines northward towards Onega, about the 60th parallel, and lastly turns in a very serpentine



line to the sources of the Kama, in the Ural Mountains, near the 62d degree of north latitude. The waters north of this line run into the Baltic and White Sea, and on the south of it into the Black Sea and the Caspian.

Thus Europe is divided into two principal hydraulic systems; but since the basin of a river comprehends all the plains and valleys drained by it and its tributaries, from its source to the sea, each country is subdivided into as many natural divisions or basins as it has primary rivers, and these generally comprise all the rich and habitable parts of the earth, and are the principal centres of civilization, or are capable of becoming so.

The streams to the north of the general watershed are very numerous; those to the south are of greater magnitude. The systems of the Volga and Danube are the most extensive in Europe: the former has a basin comprising 640,000 square miles, and is navigable throughout the greater part of its course of 1900 miles.

The Danube drains 300,000 square miles, and has 60 navigable tributaries. It rises in the Black Forest at an elevation of 3000 feet above the level of the sea, so that it has considerable velocity, which, as well as rocks and rapids, impede its navigation in many places; but it is navigable downwards, through Austria, for 600 miles to New Orsova, from whence it flows in a gentle current to the Black Sea. The commercial importance of these two rivers is much increased by their flowing into inland seas. By canals between the Volga and the rivers north of the watershed, the Baltic and White Sea are connected with the Black Sea and the Caspian, and the Baltic and Black Sea are also connected by a canal between the Don and the Dnieper. Altogether the water system of Russia is the most extensive in Europe.

The whole of Holland is a collection of deltoid islands, formed by the Rhine, the Meuse, and the Scheldt; a structure very favourable to commerce, and has facilitated an extensive internal navigation. The Mediterranean is already connected with the North Sea by the junction canal of the Rhone and the Rhine, and this noble system, extended over the whole of France by 7591 miles of canals, has conduced mainly to the improved state of that great country.

Many navigable streams rise in the Spanish mountains: of these the Tagus has depth enough for the largest ships.



In point of magnitude, however, many are of the inferior orders, but canals have rendered them beneficial to the country. Italy is less fortunate in her rivers, which only admit of vessels of small burthen. Those in the north are by much the most important, especially the Po and its tributaries, which, by steam-boats, connect Venice and Milan with various fertile provinces of central Italy; but whatever advantages nature has afforded to the Italian states have been improved by able engineers, both in ancient and modern times.

The application of the science of hydraulics to rivers took its rise in northern Italy, which has been carried to such perfection in some points that China is the only country which can vie with it in the practice of irrigation. The lock on canals was in use in Lombardy as early as the 13th century, and in the end of the 14th it was applied to two canals which unite the Ticino to the Adda, by that great artist and philosopher, Leonardo da Vinci: about the same time he introduced the use of the lock into France.

Various circumstances combine to make the British rivers more useful than many others of greater magnitude. The larger streams are not encumbered with rocks or rapids; they all run into branches of the Atlantic; the tides flow up their channels to a considerable distance; and above all, though short in their course, they end in wide gulfs, capable of containing whole navies—a circumstance that gives an importance to streams otherwise utterly insignificant when compared either with the great rivers of the old or new continent.

The Thames, whose basin is only 5027 square miles, and whose length is but 240 miles, of which however 204 are navigable, spreads its influence over the remotest parts of the earth; its depth is sufficient to admit large vessels even up to London, and throughout its navigable course a continued forest of masts display the flags of every nation; its banks, which are in a state of perfect cultivation, are the seat of the highest civilization, moral and political. Local circumstances have undoubtedly been favourable to this superior development, but the earnest and energetic temperament of the Saxon race has rendered the advantages of their position available. The same may be said of other rivers in the British islands, vying in commercial activity with the Thames. There are 2789 miles of canal in Britain, and, including rivers, 5430 miles of inland navigation, which, in comparison with the size



of the country, is very great; it is even said that no part of England is more than 15 miles distant from water communication.

On the whole, Europe is fortunate with regard to its water systems, and its inhabitants are for the most part alive to the bounties which Providence has bestowed.

### AFRICAN RIVERS.

In Africa the tropical climate and the extremes of aridity and moisture give a totally different character to its rivers. The most southerly part is comparatively destitute of them, and those that do exist are of inferior size, except the Orange River or Gareep, which has a long course on the table-land, but is nowhere navigable. There is a region of numerous rivers between the 18th degree of south latitude and the equator. They rise in two great watersheds on the table-land, from one of which they go to the Mozambique Channel and Indian Ocean, and from the other they flow to the Atlantic. The first is the range of the mountains of Nyassi, and the high lands that surround the south end of the great lake of that name, 350 miles from Mozambique. From thence all those streams come that flow over the rich plains of Mozambique and Zanguebar. Of these the Zambeze is probably the greatest, and is said to have a course of 900 miles, navigable for 200 or 300 from its mouth. Many other rivers are navigable along this coast, where grain ripens all the year, yielding from 80 to 150 fold, and every eastern production might be raised. The other watershed is a ridge of no great height, that runs from S.E. to N.W. on the table-land west of the dominions of the Zambeze. In it the numerous rivers originate which, after falling in cascades and rapids through the chains that border the table-land on the west, fertilize the luxuriant maritime plains of Benguela, Congo, Angola, and Loango. The Zaire, or Congo, by much the largest of these, is navigable for 140 miles, where the ascent of the tide is stopped by cataracts. The lower course of this river is five or six miles broad, full of islands, and 160 fathoms deep at its mouth. Its upper course, like that of most of these rivers, is unknown; the greater number are fordable on the table-land, but, from the abrupt descent of the high country to the maritime plains, none of them afford access to the interior of south Africa.



The mountainous edge of the table-land, with its terminal projections, Senegambia and Abyssinia, which separate the northern from the southern deserts, is the principal source of running water in Africa. Various rivers have their origin in these mountainous regions, of which the Nile and the Niger yield in size only to some of the great Asiatic and American rivers; in importance and historical interest the Nile is inferior to none.

Two large rivers unite their streams to form the Nile—the Bahr-el-Abiad or White Nile and the Bahr-el-Azrek or Blue Nile, but the sources and course of the White Nile are yet unknown: it is said to rise in Donga, in the Mountains of the Moon; and the Blue Nile in Abyssinia, in the table-land of Dembea, in the mountains that separate Tigré from Amhara, 10,000 feet above the sea. These two rivers converge during a long and often turbulent course, and unite at last in the plains of Senaar.

The Tecazze, the largest affluent, issues from the mountains of Lasta, and is the chief river in the kingdom of Tigré. Its affluents fall in cascades from 100 to 150 feet high, and it takes its name of Tecazze or “The Terrible” from the impetuosity with which it rushes through the chasms and over the precipices of the mountains. It joins the main stream in  $17^{\circ} 35'$  N. lat., from whence down to the Mediterranean, a distance of 1200 miles, the Nile does not receive a single brook. The first part of the Nile's course is interrupted by cataracts, from the geological structure of the Nubian desert, which consists of a succession of broad sterile terraces, separated by ranges of rocks running east and west. Over these the Nile runs in nine or ten cataracts, the last of which is at Syene, where it enters Egypt. Most of them are only rapids, where each successive fall of water is not a foot high. That they were higher at a former period has recently been ascertained by Dr. Lepsius, the very intelligent traveller sent by the King of Prussia at the head of a mission to explore that country. He found a series of inscriptions on the rocks in Senaar, marking the height of the Nile at different periods; and it appears from these that in that country the bed of the river had been 30 feet higher than it is now.

Fifteen miles below Cairo, and 90 miles from the sea, the Nile is divided into two branches, of which, one, running in a northerly direction, enters the Mediterranean be-



low Rosetta ; the other, cutting Lower Egypt into two nearly equal parts, enters the sea above Damietta ; so that the delta between these two places has a sea-coast of 150 miles.

The basin of the Nile, occupying an area of 500,000 square miles, has an uncommon form : it is wide in Ethiopia and Nubia ; but for the greater part of a winding course of 2750 miles it is merely a verdant line of the softest beauty, suddenly and strongly contrasted with the dreary waste of the Red desert. Extending from the equatorial far into the temperate zone, its aspect is less varied than might have been expected on account of the parched and showerless country it passes through. Nevertheless, from the great elevation of the origin of the river, the upper part has a perpetual spring, though within a few degrees of the equator. At the foot of the table-land of Abyssinia the country is covered with dense tropical jungles, while the rest of the valley is rich soil, the detritus of the mountains for thousands of years.

As the mean velocity of the Nile, when not in flood, is about two miles and a half an hour, a particle of water would take twenty-two days and a half to descend from the junction of the Tecazze to the sea ; hence the retardation of the annual inundations of the Nile in its course is a peculiarity of this river, owing to some unknown cause towards its origin which affects the whole stream. In Abyssinia and Senaar the river begins to swell in April, yet the flood is not sensible at Cairo till towards the summer solstice ; it then continues to rise about a hundred days, and remains at its greatest height till the middle of October, when it begins to subside, and arrives at its lowest point in April and May. The height of the flood in Upper Egypt varies from 30 to 35 feet ; at Cairo it is 23, and in the northern part of the Delta only 4 feet.

Annubis, or Sirius, the Dog-star, was worshipped by the Egyptians, from its supposed influence on the rising of the Nile. According to Champolion, their calendar commenced when the heliacal rising of that star coincided with the summer solstice, the time at which the Nile began to swell at Cairo. Now this coincidence made the nearest approach to accuracy 3291 years before the Christian era ; and as the rising of the river still takes place precisely at the same time and in the same manner, it follows that the heat and periodical rains in Upper Ethiopia have not varied for 5000 years. In the time of Hipparchus the summer solstice was in the sign of



Leo ; and probably about that period the flowing of the fountains from the mouths of lions of basalt and granite was adopted, as emblematical of the pouring forth of the floods of the Nile. The emblem is still common in Rome, though its origin is probably forgotten ; and the signs of the zodiac have moved backwards more than  $30^{\circ}$ .

The two greatest African rivers, the Nile and the Niger, are dissimilar in almost every circumstance ; the Nile, discharging itself for ages into a sea, the centre of commerce and civilization, has been renowned by the earliest historians, sacred and profane, for the exuberant fertility of its banks and for the learning and wisdom of their inhabitants, who have left magnificent and imperishable monuments of their power and genius. It was for ages the seat of science, and by the Red Sea it had intercourse with the most highly cultivated nations of the East from time immemorial. The Niger, on the contrary, though its rival in magnitude, and running through a country glowing with all the brilliancy of tropical vegetation, has ever been inhabited by barbarous or semi-barbarous nations ; and its course till lately was little known, as its source still is. In early ages, before the pillars of Hercules had been passed, and indeed long afterwards, the Atlantic coast of Africa was an unknown region ; and thus the flowing of the Niger into that lonely ocean kept the natives in their original rude state. Such are the effects of local circumstances on the intellectual advancement of man.

The sources of the Niger, Joliba, or Quorra, are supposed to be on the northern side of the Kong Mountains, in the country of Bambarra, more than 1600 feet above the level of the sea. From thence it goes north, and, after passing through Lake Debo, makes a wide circuit in the plains of Soudan to Timbuctoo, through eight or nine degrees of latitude ; then bending round, it again approaches the Kong Mountains, at the distance of 1000 miles in a straight line from its source ; and having threaded them, it flows across the low lands into the Gulf of Guinea, a course of 2300 miles. In the plains of Soudan it receives many very large affluents from the high land of Senegambia on the west ; and the Chadda on the east—a navigable river larger than itself, the outlet of the great Lake Chad, which drains the lofty Komri, or Mountains of the Moon—falls into it a little



below Fandah after a course of some hundred miles: thus it affords an uninterrupted water communication from the Atlantic to the heart of Africa. Long before leaving the plains of Soudan the Niger becomes a noble river, with a smooth stream, gliding at the rate of from five to eight miles an hour, varying in breadth from one to eight miles. Its banks are studded with densely populous towns and villages, groves of palm-trees and cultivated fields.

This great river divides into three branches near the head of a delta which is equal in area to the whole of Ireland, intersected by navigable branches of the principal stream in every direction. The soil is rich mould, and the vegetation so rank that the trees seem to grow out of the water. The Nun, which is the principal or central branch, flows into the sea near Cape Formosa, and is that which the brothers Lander descended. There are, however, six rivers which run into the Bight of Benin, all communicating with the Niger, and with one another. The Old Calabar is the most eastern; it rises in the high land of the Calbongos, and is united to the Niger by a natural canal. The Niger throughout its long winding course lies entirely within the tropic of Cancer, and is consequently subject to periodical inundations, which reach their greatest height in August, about 40 or 50 days after the summer solstice. The plains of Soudan are then covered with water and crowded by boats. These fertile regions are inaccessible to Europeans from the pernicious climate, and dangerous from the savage condition of many of the tribes.

The coast of Guinea west from the Niger is watered by many streams of no great magnitude from the Kong-Mountains. The table-land of Senegambia is the origin of the Rio Grande, the Gambia, the Senegal, and others of great size, and also many of an inferior order that fertilize the luxuriant maritime plains on the Atlantic. Their navigable course is cut short by a semicircular chain of mountains which forms the western boundary of the high land through which they thread their way in rapids and cataracts. The Gambia rises in Fouta Toro, and after a course of about 600 miles enters the Atlantic by many branches connected by natural channels, supposed at one time to be separate rivers. The Senegal, the largest river in this part of Africa, is 850 miles long. It receives many tributaries in the upper



part of its course, and in the lower is full of islands. It drains two lakes, has several accessories, and is united to the basin of the Gambia by the river Neriho.

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## CHAPTER XVII.

ASIATIC RIVERS—EUPHRATES AND TIGRIS—RIVER SYSTEMS  
SOUTH OF THE HIMALAYA—CHINESE RIVERS—SIBERIAN  
RIVERS.

THE only river system of importance in western Asia is that of the Euphrates and Tigris. In the basin of these celebrated streams, containing an area of 230,000 square miles, mounds of rubbish on a desolate plain are the only vestiges that remain of the great cities of Nineveh and Babylon. Innumerable ruins and inscriptions, also records of the glory of times less remote, have been discovered by adventurous travellers, and bear testimony to the truth of some of the most interesting pages of history. The Euphrates, and its affluent the Merad-Chai, supposed to be the stream forded as the Euphrates by the 10,000 Greeks in their retreat, rise in the heart of Armenia, and, after running 1800 miles on the table-land to  $38^{\circ} 41'$  of north latitude, they join the northern branch of the Euphrates, which rises in the Gheul Mountains, near Erzeroum. The whole river then descends in rapids through the Taurus chain, north of Rumkala, to the plains of Mesopotamia.

The Tigris comes from Dearbeker, more to the east, and, after receiving auxiliaries from the high lands Kourdistan, it pierces the Taurus Mountains at Mosul, and descends rapidly in a tortuous course to the same plains, where it is joined by many streams from the Lusistán Mountains, some of which are navigable, and may ultimately be of great commercial importance. The country through which they flow is extremely beautiful, and rich in corn, date-groves, and forest-trees. Near the city of Bagdad, the two rivers, approaching, surround the plain of Mesopotamia, unite at Koona, and run 150 miles in one stream to the Persian Gulf, under the name of Chat-el-Arab. The banks of the



Tigris and Euphrates are quite desolate, alternately vast swamps or burnt up, and in many parts covered with brush-wood or grass. The remains of numerous canals, joining these great rivers and their affluents, show the former magnitude of this most ancient water system. The floods of this river are very regular in their periods; they begin in March, and attain their greatest height in June.

The Persian Gulf may be navigated by steam all the year, the Euphrates only eight months; it might however afford easy intercourse with eastern Asia, as it did in former times. The distance from Aleppo to Bombay by the Euphrates is 2870 miles, of which 2700, from Bir, to Bombay, are by water; in the time of Queen Elizabeth this was the common route to India, and a fleet was then kept at Bir expressly for that navigation.

Five systems of rivers of the first magnitude descend from the central table-land of eastern Asia and its mountain barriers, all different in origin, direction, and character, while they convey to the ocean a greater volume of water than all the rivers of the rest of the continent conjointly. Of these, the Indus, the double system of the Ganges and Brahmapootra, and the group of parallel rivers in the Indo-Chinese peninsula, water the plains of southern Asia; the great system of rivers that descend from the eastern terraces of the table-land irrigate the fertile lands of China; and lastly, the Siberian rivers, not inferior to any in magnitude, carry the waters of the Altaï to the Arctic Ocean.

The hard-fought battles and splendid victories recently gained by British valour over a bold and well-disciplined foe have added to the historical interest of the Indus and its tributary streams, now the boundaries of our Asiatic territories.

The sources of the Indus and Sutlej were only ascertained in 1812: the Ladak, the largest branch of the Indus, has its origin in the snowy mountains of Karakorum; and the Shyook, which is the smaller stream, rises in the Kentese or Kangri range, a branch of the Himalaya, which extends along the table-land of Tibet, west of the sacred lake of Manasarora. These two streams join north-west of Ladak, and form the Indus; the Sutlej, its principal tributary, springs from the sacred lake itself. Both are fed by streams of melted snow from the northern side of the Himalaya, and both flow



westward along the extensive longitudinal valleys of Tibet. The Sutlej breaks through the Himalaya about the 75th meridian, and traverses the whole breadth of the chain in frightful chasms and clefts in the rocks to the plains of the Punjab; the Indus, after continuing its course on the table-land through several degrees of longitude farther, descends by the Hindoo Coosh, west of the valley of Cashmere, to the same plain. Three tributaries, the Jelum or Hydaspes, the Hydraotes, and the Chenab, all superior to the Rhone in size, flow from the southern face of the Himalaya, and with the Sutlej join the Indus before it reaches Mittum; hence the name Punjab, "the plain of the five rivers," now one of our valuable possessions in the East. From Mittum to the ocean, the Indus, like the Nile, does not receive a single accessory, from the same cause—the sterility of the country through which it passes. The Cabul river, which rises near Guzni, but is joined by a larger affluent from the lofty plain of Pamere, flows along the edge of the Persian table-land, through picturesque and dangerous defiles, and forms the limit between eastern and western Asia. It then joins the Indus at the town of Attock, and is the only tributary of any magnitude that comes from the west.

The Indus is not favourable to navigation: for 70 miles after it leaves the mountains the descent in a boat is dangerous, and it is nowhere navigable for steam-vessels of more than 30 inches draught of water; yet, from the fertility of the Punjab, and the near approach of its basin to that of the Ganges at the foot of the mountains, it must ultimately be a valuable acquisition, and the more especially because it commands the principal roads between Persia and India, one through Cabul and Peshawer to Attock, and the other from Herat through Candahar to the same place. The delta of the Indus, formerly celebrated for its civilization, has long been a desert; but from the vitality of the soil, and the change of political circumstances, it may again resume its pristine aspect. It is 60 miles long, and presents a face of 120 miles to the sea at the Gulf of Oman, where the river empties itself by many mouths, of which only three or four are navigable: one only can be entered by vessels of 50 tons, and all are liable to change. The tide ascends them with extraordinary rapidity for 75 miles, and so great is the quantity of mud carried by it and the absorbing violence of



the eddies, that a vessel wrecked on the coast was buried in sand and mud in two tides. The annual floods begin with the melting of the snow in the Himalaya in the end of April, come to their height in July, and end in September. The length of this river is 1500 miles, and it drains an area of 400,000 square miles.

The second group of south Indian rivers, and one of the greatest, is the double system of the Ganges and Brahmapootra. These two rivers, though wide apart at their sources, converge to a common delta, and constitute one of the most important groups on the globe.

Mr. Alexander Elliot, of the Body Guard in Bengal, son of Admiral Elliot, with his friends, are the first who have accomplished the arduous expedition to the sources of the Ganges. The river flows at once in a very rapid stream not less than 40 yards across, from a huge cave in a perpendicular wall of ice at the distance of about three marches from the temple of Gungootree, to which the pilgrims resort. Mr. Elliot says, "The view from the glacier was perfectly amazing; beautiful or magnificent is no word for it—it was really quite astonishing. If you can fancy a bird's-eye view of all the mountains in the world in one cluster, and every one of them covered with snow, it would hardly give you an idea of the sight which presented itself."

Many streams from the southern face of the Himalaya unite at Hurdwar to form the great body of the river. It flows from thence in a south-easterly direction through the plains of Bengal, receiving in its course the tribute of 19 or 20 rivers, of which 12 are larger than the Rhine. About 220 miles in a direct line from the Bay of Bengal, into which the Ganges flows, the innumerable channels and branches into which it splits form an intricate maze over a delta twice as large as that of the Nile.

The sources of the Brahmapootra, a river equal in volume to the Ganges, though not in length, are some hundreds of miles distant from those of the latter. They lie to the north of the Birman empire, but whether they spring from the eastern extremity of the Himalaya or from some snow-clad branch of it is unknown. The upper course of the river among the lofty defiles of the mountains is completely zigzag, but soon after passing through the sacred pool of Brahma-Koond it enters the plains of Upper Assam, and receives



the name of Brahmapootra—"the offspring of Brahma; the natives call it the Lahit, Sanscrit for "red river." In Upper Assam, through which it winds 500 miles and forms some very extensive channel islands, it receives six very considerable accessories, of which the origin is unknown, though some are supposed to come from the tableland of Tibet. They are only navigable in the plains, but vessels of considerable burthen ascend the parent stream as high as Sampura. Before it enters the plains of Bengal, below Goyalpara, the Brahmapootra runs with rapidity in great volume, and, after receiving the river of Bhotan and other streams, its branches unite with those of the Ganges about 40 miles from the coast, but the two rivers enter the sea by different mouths, though they sometimes approach within two miles. The length of the Brahmapootra is probably 860 miles, so that it is 500 miles shorter than the Ganges: the volume of water discharged by it during the dry season is about 146,888 cubic feet in a second; the quantity discharged by the Ganges in the same time and under the same circumstances is only 80,000 cubic feet. In the perennial floods the quantity of water poured through the tributaries of the Brahmapootra from their snowy sources is incredible: the plains of Upper Assam are an entire sheet of water from the 15th of June to the 15th of September, and there is no communication but by elevated causeways eight or ten feet high: the two rivers with their branches lay the plain of Bengal under water for hundreds of miles annually. They begin first to swell from the melting of the snow on the mountains; but before their inferior streams overflow from that cause, all the lower parts of Bengal adjacent to the Ganges and Brahmapootra are under water, from the swelling of these rivers by the rains. The increase is arrested before the middle of August by the cessation of the rains in the mountains, though they continue to fall longer in the plains. The delta is traversed in every direction by arms of the rivers. The Hoogly branch, at all times navigable, passes Calcutta and Chandernagor; and the Hauringgotta arm is also navigable, as well as the Ganges properly so called. The channels, however, are perpetually changing from the strength of the current and the prodigious quantity of matter washed from the high lands; the Ganges alone carries to the sea 600,000 cubic feet of mud in a second, the



effects of which are perceptible 60 miles from the coast. The elevation of the mountains, and indeed of the land generally, must have been enormous, since it remains still so stupendous after ages of such degradation. The Sunderbands, a congeries of innumerable river islands formed by the endless streams and narrow channels of the rivers, as well as by the indentations of arms of the sea, line the coast of Bengal for 180 miles—a wilderness of jungle and heavy timber. The united streams of the Ganges and Brahmapootra drain an area of 650,000 square miles, but there is scarcely a spot in Bengal more than 20 miles distant from a river navigable even in the dry season.

These three great rivers of southern India do not differ more widely in their physical circumstances than in the races of men who inhabit their banks, yet from their position they seem formed to unite nations the most varied in their aspect and speech. The tributaries of the Ganges and Indus come so near to each other at the foot of the mountains, that a canal only two miles long would unite them, and thus an inland navigation from the Bay of Bengal to the Gulf of Oman might be established.

An immense volume of water is poured in a series of nearly parallel rivers of great magnitude and strength through the Indo-Chinese peninsula into the ocean opposite the Sunda Archipelago. They rise in those elevated regions at the south-eastern angle of the table-land of Tibet, the lofty but unknown provinces of the Chinese empire, and water the great valleys that extend nearly from north to south with perfect uniformity, between chains of mountains no less uniform, which spread out like a fan as they approach the sea. Scarcely any thing is known of the origin or upper parts of these rivers, and with a few exceptions almost as little of the lower.

Their number amounts to six or seven, all large, though three surpass the rest—the Irrawaddy, which waters the Birman empire, and falls into the Bay of Bengal at the Gulf of Martaban; the Meinam or river of Siam; and the river of Cambodja, which flows through the empire of Annam: the two last go into the China Sea.

The sources of the Irrawaddy are in the same chain of mountains with those of the Brahmapootra, more to the south. Its course is through countries hardly known to



Europeans, but it seems to be navigable by boats coming to the city of Amarapoora, south of which it enters the finest and richest plain of the empire, containing its four capital cities. There it receives two large affluents, one from the Chinese province of Yunnah, which flows into the Irrawaddy at the city of Ava, 446 miles from the sea, the highest point attained by the British force during the Birmese war.

From Ava to its delta the Irrawaddy is a magnificent river, more than four miles broad in some places, but encumbered with channel islands. In this part of its course it receives its largest tributary, and forms in its delta one of the most extensive systems of internal navigation. The Rangoon is the only one of its 14 mouths that is always navigable, and in it the commerce of the empire is concentrated. The internal communication is extended by the junction of the two most navigable deltoid branches with the rivers Salven and Pegu, by natural canals: that joining the former is 200 miles long; the canal uniting the latter is only serviceable at high water.

The Meinam, one of the largest Asiatic rivers, is less known than the Irrawaddy: it comes from the Chinese province of Yunnan and runs through the kingdom of Siam, which it cuts into several islands by many diverging branches, and enters the Gulf of Siam by three principal arms, the most easterly of which forms the harbour of Bangkok. It is joined to the Meinam Kong or Cambodja by the small river Anan-Myit.

The river of Cambodja has the longest course of any in the peninsula; it is supposed to be the Lang-thsang, which rises in the high land of K'ham, in eastern Asia, not far from the sources of the great Chinese river, the Yang-tsi-kiang. After traversing the elevated plain of Yunnan, where it is navigable, it rushes through the mountain barriers; and on reaching a wider valley, about 300 miles from its mouth, it is joined to the Meinam by the natural canal of the Anan-Myit. More to the south it is said to split into branches which unite again.

The ancient capital of Annam is situated on the Cambodja, about 150 miles from the sea: a little to the south its extensive delta begins, projects far into the ocean, and is cut in all directions by arms of the river navigable during the floods; three of its mouths are permanently so for large



vessels up to the capital. The Sai-gon, more to the east, is much shorter than the river of Cambodja, though said to be 1000 miles long; but Europeans have not ascended higher than the town of Sai-gon. Near its mouth it sends off several branches to the eastern arm of the Cambodja. All rivers of this part of Asia are subject to periodical inundations, which fertilize the plains at the expense of the mountains.

The parallelism of the mountain-chains constitutes formidable barriers between the upper basins of the Indo-Chinese rivers, and decided lines of separation between the inhabitants of the intervening valleys; but this inconvenience is in some degree compensated by the natural canals of junction and the extensive water communication towards the mouths of the rivers.

“The Sons of the Ocean,” a double system of colossal rivers which drain 1,400,000 square miles of the Chinese empire, rise in the two extensive and principal terraces on the eastern slope of the table-land of central Asia. The length of the Hoang-Ho is 2000 miles, that of the Yang-tsi-kiang 2900. Though near at their beginning, they are widely separated north and south, as they proceed on their eastern course, by the mountain-chains that border the table-land; but they again approach, and are not more than 100 miles apart when they enter the Whang-Hai or Yellow Sea. They are united in central China by innumerable canals, and form the grandest and most extensive water system in existence.

The Hoang-Ho brings down in one hour 2,000,000 cubic feet of earth, whence, like the Tiber of old, it is called the “Yellow” River.

Strong tides from the Pacific go up these rivers 400 miles, and for the time prevent the descent of the fresh water, which forms large interior seas frequented by thousands of trading-vessels, and they irrigate the productive lands of central China, from time immemorial the most highly cultivated and the most densely peopled region of the globe.

Almost all the Chinese rivers of less note—and they are numerous—feed these giant streams, with the exception of the Ta-si-kiang, and the Pei-ho, or White River, which have their own basins. The former, rising to the east of the town of Yunnan, flows through the plains of Canton



eastward to the Gulf of Canton, into which it discharges itself, increased in its course by the Sekiang.

The White River, rising in the mountains near the great wall, becomes navigable a few miles east of Pekin, unites with the Eu-ho, joins the great canal, and, as the tide ascends it for 80 miles, it is crowded with shipping.

Four great rivers, the Amur, the Lena, the Yenessee, and the double system of the Irtysh and Oby, not inferior in size to any rivers in Asia, carry off the waters that come from the Altaï chain, and from the mountains and terraces on the northern declivity of the central table-land. Two of these, the Amur and Lena, rise in the Baikalian mountains, the source of more great rivers than any group of its size. The Amur, the sources of which are partly in the Russian dominions, though its course is chiefly in China, is 2000 miles long, including its windings, and has a basin of 853,000 square miles. Almost all its accessories come from that part of the Baikalian group called the Yablonnoi Khrebit by the Russians, and Khing-Khan-Oola by the Chinese. The river Onon, which is the parent stream, has its origin in the Khentai Khan, a branch of the latter; and though its course is through an uninhabited country, it is celebrated as being the birthplace and the scene of the exploits of Tshingis Khan. After passing through the lake of Dalai-nor, which is 210 miles in circumference, it takes the name of Argun, and forms the boundary between the Chinese and Russians for 400 miles: it is then joined by the Silka, where it assumes the Tunguse name of the Amur, or Great River; the Mandchoos call it the Saghalia, or Black Water. It receives most of the unknown rivers that come from the mountain-slopes of the Great Gobi, and falls into the Pacific opposite to the island of Tarakaï, after having traversed three degrees of latitude and thirty-three of longitude.

The Lena, whose basin occupies 800,000 square miles, springs from mountains 20 miles west from the Lake of Baikal, and runs north-east through more than half its course to the Siberian town of Yakutzk, the coldest town on the face of the earth, receiving in its course the Witim and the Alekma, its two principal affluents; the former from the Baikal Mountains, the latter from Stannovoi Khrebit, the most southerly part of the Aldan range. North of Yakutzk, about the 63d parallel of latitude, the Lena receives the



Aldan, its greatest tributary, which also comes from the Stannovoi Khrebit: it then goes to the Arctic Ocean, between banks of frozen mud, prodigious masses of which are hurled down by the summer floods, and bring to view the bones of those huge animals of extinct species which at some remote period had found their nourishment in these desert plains. The length of the Lena including its windings is 1900 miles.

A difference in the pressure of the air has been observed on the banks of this river, on the shores of the sea of Okhotsk, and at Kamtschatka, which shows that in the distance of five degrees of latitude there is an *apparent* difference in the level of the sea amounting to 159 feet.\* A similar phenomenon was observed by Captain Foster near Cape Horn, and by Sir James Ross throughout the South Polar Ocean.

The Yenessei, a much larger river than the Lena, drains about 1,000,000 square miles, and is formed by the union of the Great and Little Kem. The former rises at the junction of the Sayansk range with the Baikalian mountains to the north-west of Lake Kassagol; the latter comes from the Egtag or Little Altaï, in quite an opposite direction; so that these two meet at nearly right angles, and take the name of Yenessei: it then crosses the Sayansk range in cataracts and rapids, entering the plains of Siberia below the town of Krasnagarsk. Many rivers join it in this part of its course, chiefly the Angora from the Lake Baikal; but its greatest tributaries, the Upper and Lower Tungurka, both large rivers from the Baikalian mountains, join it lower down, the first to the south, the latter to the north of the town of Yeniseisk, whence it runs north to the Icy Ocean, there forming a large gulf, its length measured along its bed being 2500 miles.

The Oby rises in the Lake of Toleskoi, "The Lake of Gold," in Great Tartary; all the streams of the Lesser Altaï unite to swell it and its great tributary the Irtysh. The rivers which come from the northern declivity of the mountains go to the Oby, those from the western sides to the Irtysh, which springs from numerous streams on the southwestern declivity of the Little Altaï, and runs westward into

\* M. Erman.



Lake Zainzan, 200 miles in circumference. Issuing from thence it takes a westerly course to the plain on the north of Semissalatinsk. In the plain it is joined by the Tobol, which crosses the steppe of the Kirghiz Cossacks from the Ural Mountains, and soon unites with the Oby: the joint stream then proceeds to the Arctic Ocean in  $67^{\circ}$  N. latitude. The Oby is 2000 miles long, and the basin of these two rivers occupy a third part of Siberia.

Before the Oby leaves the mountains, at a distance of 1200 miles from the Arctic Ocean, its surface has an absolute elevation of not more than 400 feet, and the Irtysh, at the same distance, is only 72 feet higher, both are consequently sluggish. When the snow melts they cover the country like seas; and as the inclination of the plains, in the middle and lower parts of their course, is not sufficient to carry off the water, those immense lakes and marshes are formed which characterize this portion of Siberia.

The bed of Oby is very deep; and there are no soundings at its mouth: hence the largest vessels might ascend at least to its junction with the Irtysh. Its many affluents also might admit ships, did not the climate oppose an insurmountable obstacle the greater part of the year. Indeed, all Siberian rivers are frozen annually for many months, and even the ocean along the Arctic coasts is rarely disencumbered from ice; consequently these vast rivers never can be important as navigable streams; but towards the mountains they afford water communication from the steppe of Issim to the Pacific. They abound in fish and waterfowl, for which the Siberian braves the extremest severity of the climate.

Local circumstances have nowhere produced a greater difference in the human race than in the basins of the great rivers north and south of the table-land of eastern Asia. The Indian, favoured by the finest climate, and a soil which produces the luxuries of life, intersected with rivers navigable at all seasons, and affording easy communication with the surrounding nations, attained early a high degree of civilization; while the Siberian and Samoide, doomed to contend with the rigours of the polar blasts in order to maintain mere existence, have never risen beyond the lowest grade of humanity: but custom softens even the rigour of this stern life, so that here also a share of happiness is enjoyed.



## CHAPTER XVIII.

## RIVER SYSTEMS OF NORTH AMERICA—RIVERS OF CENTRAL AMERICA—RIVERS OF SOUTH AMERICA, AND OF AUSTRALIA.

NORTH America is divided into four distinct water systems by the Rocky Mountains, the Alleghanies, and a table-land which contains the great lakes, and separates the rivers that flow into the Arctic Ocean from those that go to the Gulf of Mexico. This table-land is a level, nowhere more than 1200 or 1500 feet above the surface of the sea, and is itself drained by the St. Lawrence and the rivers that flow into Hudson's Bay. The St. Lawrence rises in Lake Superior, and, after joining the five great lakes, runs north-east into the Atlantic, and ends in a wide estuary. It has a basin of 537,000 square miles, of which 149,000 are covered with water, exclusive of the many lesser lakes with which it is in communication.

North of the watershed there is an endless and intricate labyrinth of lakes and rivers, almost all connected with one another. But the principal streams of these arctic lands are the Great Fish River, which flows north-east in a continued series of dangerous and all-but impassable rapids to the Arctic Ocean at Melville Strait. The Copper-mine River, of much the same character, after traversing many lakes, enters the Icy Sea at George IV.'s Gulf; and the M'Kenzie, a stream of greater magnitude, formed by the confluence of the Peace River and the Athabasca from the Rocky Mountains, after flowing north over 16 degrees of latitude, enters the frozen ocean in the Esquimaux country somewhere beyond the arctic circle. All these rivers are frozen more than half the year, and the M'Kenzie, in consequence of its length and direction from south to north, is subject to floods like the Siberian rivers, because its lower course remains frozen for several hundred miles, long after the upper part is thawed, and the water, finding no outlet, flows over the ice and inundates the plains.

South of the table-land the valley of the Mississippi extends for 1000 miles, and the greatest of North American



river has its origin in the junction of streams from the small lakes Itaska and Ussawa, on the table-land, at no greater height than 1500 feet above the sea. Before their junction these streams frequently spread out into sheets of water, and the Mississippi does the same in the upper part of its course. This river flows from north to south through more degrees of latitude than any other, and receives so many tributaries of the higher orders, that it would be difficult even to name them. Among those that swell its volume from the Rocky Mountains, the Missouri, the Arkansas, and the Red River are the largest, each being in itself a mighty stream, receiving tributaries without number. Before their junction the Missouri is a much superior stream, both in length and volume, to the Mississippi, and has various affluents larger than the Rhine. It rises in about  $44^{\circ}$  N. lat., and runs partly in a longitudinal valley of the Rocky Mountains and partly at their foot, and drains the whole of the country on the right bank of the Mississippi, between the 49th and 40th parallels of north latitude. It falls in cataracts through the mountain regions, but in the plains it sometimes passes through dense forests and sometimes through large prairies, in all accomplishing 3000 miles in a very tortuous and generally south-eastern direction, till it is confluent with the Mississippi near the town of St. Louis. Lower down the Mississippi is joined first by the Arkansas, 2000 miles long, with many accessories, and then by the Red River, the former from the Rocky Mountains, but the latter, which rises in the table-land of New Mexico, is fed by streams from the Sierra dal Sacramento, and enters the main stream not far from the beginning of the delta which stretches in a long tongue of land into the Gulf of Mexico.

The tributaries from the Rocky Mountains, though much longer, run through countries of less promise than those which are traversed by the Ohio and the other rivers that flow into the Mississippi on the east, which offer advantages unrivalled even in this wonderful country, only beginning to be developed. The Ohio is formed by the union of the rivers Alleghany and Monongahela, the latter from the Laurel ridge of the Alleghany chain in Virginia, the former comes from sources near Lake Erie, and the two unite at Pittsburg, from whence the river winds for 948 miles through some of the finest States of the Union, till its junction with the Missis-



issippi, having received many accessories, six of which are navigable streams. There are some obstacles to navigation in the Ohio, but they have been avoided by canals. Other canals join both the Mississippi and its branches with Lake Erie, so that there is an internal water communication between the St. Lawrence and the Gulf of Mexico. The whole length of the Mississippi is 3160 miles, but if the Missouri be considered the main stem, it is 4265, and the joint stream drains an area of about a million and a quarter of square miles. The breadth of the river nowhere corresponds with its length. At the confluence of the Missouri each river is half a mile wide, and after the junction of the Ohio it is not more. The depth is 168 feet where it enters the Gulf of Mexico at New Orleans. This great river is a rapid, desolating torrent loaded with mud: its violent floods, by the melting of the snow in the high latitudes, sweep away whole forests, by which the navigation is rendered very dangerous; and the trees, being matted together in masses many yards thick, are carried down by the spring floods, and deposited over the delta and Gulf of Mexico for hundreds of square miles.

North America can boast of two other great water systems, one from the eastern versant of the Alleghanies, which flows into the Atlantic, and another from the western versant of the Rocky Mountains, which runs into the Pacific.

All the streams that flow eastward through the United States to the Atlantic are short and comparatively small, but of the highest utility, because many of them, especially those to the north, end in gulfs of vast magnitude, and the whole are so united by canals, that few places are not accessible by water, one of the greatest advantages a country can possess. There are at least 24 canals in the United States, the whole length of which is 3101 miles.

Many of the streams that ultimately come to the Atlantic, rise in the western ridges of the Alleghany chain, and traverse its longitudinal valleys before leaving the mountains to cross the Atlantic slope, which terminates in a precipitous ledge for 300 miles parallel to the range. By falling over this rocky barrier in long rapids and picturesque cascades, they afford an enormous and extensive water power: and as the rivers are navigable from the Atlantic quite across the maritime plains, these two circumstances have determined the location of most of the principal cities of the United



States at the foot of this rocky ledge, which, though not more than 300 feet high, has had a greater influence on the political and commercial interests of the Union, than the highest chains of mountains have had in other countries.

The watershed of the Rocky Mountains lies at a greater distance from the Pacific than that of the Alleghanies from the Atlantic ; consequently the rivers are longer, but they are few and little known. The largest are the Oregon or Colombia and the Rio Colorado. The former has its source not far from those of the Rio del Norte, and after an exceedingly tortuous course, in which it receives many tributaries, it falls into the Pacific at Astoria. The Colorado is a Mexican stream, which comes from the Sierra Verde, and falls into the Gulf of California.

There are many streams in Central America, and above ten rivers that are navigable for some miles ; six of these fall into the Gulf of Mexico and Caribbean Sea, and four into the Pacific.

The Andes, the extensive watershed of South America, are so close to the Pacific, that, excepting a few small streams at their southern extremity, there are no rivers on that side, and even the streams that rise in the western Cordilleras find their way to the eastern plains.

The Magdalena, at the northern end of the Andes, though a secondary river in America, is 620 miles long. It rises in the central chain, at the divergence of the Cordillera of Santa Fé de Bogota, and enters the Caribbean Sea by various channels, navigable to Honda. The Cauca, its only feeder on the left, comes from Popayan, and is nearly as large as its primary, to which it runs parallel the greater part of its course. Many streams join the Magdalena on the right, as the Funzha, which waters the elevated plain of Bogota and forms the cataract of Tequendama, one of the most beautiful and wildest scenes in the Andes. The river rushes through a chasm 30 feet wide, which appears to have been formed by an earthquake ; and at a double bound descends 530 feet into a dark gloomy pool, illuminated only at noon by a few feeble rays. A dense cloud of vapour rising from it is visible at the distance of 15 miles. At the top the vegetation is that of a temperate climate, while palms grow at the bottom.

With the exception of the Magdalena, all the water from



the inexhaustible sources of the Andes is poured into the Orinoco, the river of the Amazons, and the Rio de la Plata, which convey it eastward across the continent to the Atlantic.

The basins of these three rivers are separated in their lower parts by the mountains and high lands of the Parima and Brazil ; but the upper parts of the basins of all three, towards the foot of the Andes, form an extensive level, and are only divided from one another by imperceptible elevations in the plains, barely sufficient to form the watersheds between the tributaries of these majestic rivers. This peculiar structure is the cause of the natural canal of the Cassiquiare, which joins the upper Orinoco with the Rio Negro, a principal affluent of the Amazons. Ages hence, when the wilds are inhabited by civilized men, the tributaries of these three great rivers, many of which are navigable to the foot of the Andes, will, by means of canals, form a water system infinitely superior to any that now exists.

The Orinoco, altogether a Colombian river, rises in the Sierra del Parima, 200 miles east of Duida, and maintains a westerly course to San Fernando de Atabapa, where it receives the Atabapa, and Guaviare, which is larger than the Danube, and here ends the upper Orinoco. The river then forces a passage through the Sierra del Parima, and runs due north, for three degrees of latitude, between banks almost inaccessible ; its bed is traversed by dykes and filled with boulders of granite, and islands clothed with a variety of magnificent palm-trees. Large portions of the river are here engulfed in crevices, forming subterranean cascades ; and in this part are the celebrated falls of the Atures and Apures, 36 miles apart, which are heard at the distance of many miles. At the end of this tumultuous part of its course it is joined by the Apure, a very large river, and then runs eastward to its mouth, where it forms a large delta, and enters the Atlantic by many channels. As the upper Orinoco runs west, and the lower Orinoco east, it makes a complete circuit round the Parima mountains, so that its mouth is only two degrees distant from the meridian of its sources.

The Cassiquiare leaves the Orinoco at the point where the rapids begin, and joins the Rio Negro, a chief tributary of the Amazons, at the distance of 180 miles.

The Orinoco is navigable 1000 miles, and at all seasons ;



a fleet might ascend it from the Dragon's mouth to within 45 miles of Santa Fé de Bogota. It receives many navigable rivers, of which the Guaviare, the Atures, and the Meta are each larger than the Danube. The Meta may be ascended to the foot of the Andes; its mean depth is 36 feet, and in many places 80 or 90. It rises so high in the Andes, that Baron Humboldt says the vegetable productions at its source differ as much from those at its confluence with the Orinoco, though in the same latitude, as the vegetation of France does from that of Senegal. The larger feeders of the Orinoco come from the Andes, though many descend to it from both sides of the Parima, in consequence of its long circuit among these mountains.

The basin of the Orinoco has an area of 300,000 square miles, of which the upper part is impenetrable forest, the lower is Llanos.

The floods of the Orinoco, like those of all rivers entirely within the torrid zone, are very regular, and attain their height nearly at the same time with those of the Ganges, the Niger, and the Gambia. They begin to swell about the 25th of March, and arrive at their full and begin to decrease on the 25th of August. The inundations are very great, owing to the quantity of rain that falls in the wooded regions, which exceeds 100 inches in a year.

Below the confluence of the Apure, the river is three miles and a quarter broad, but during the floods it is three times as much. By the confluence of four of its greatest tributaries, at the point at which it bends to the east, a low inland delta is formed, in consequence of which 3600 square miles of the plain are under water during the inundation. The Orinoco in many parts smells of musk, from the number of dead crocodiles.

Upper Peru is the cradle of the Amazons, the greatest of rivers. It issues in two streams from the Lauricocha or Lake Laura, in the elevated plain of Bombon, on the summit of the Andes. Joined by many other streams, it pursues a northerly course between the lateral Cordilleras, till it bursts through the eastern ridge by the Pongo or pass of Manse-riche, and descends to the flat and wooded plain at the foot of the mountains; from whence it flows uniformly eastward till it reaches the Atlantic, having accomplished a course of 3200 miles, or more properly 4000, including its windings,



and drained an area of two millions and a half of square miles, which is ten times the size of France. In some places it is 600 feet deep ; it is navigable 2200 miles from its source, and is 96 miles wide at its mouth.

The name of this river is three times changed in its course : it is known as the Marañon from its source to the confluence of the Ucayale ; from that point to its junction with the Rio Negro, it is called the Solimões : and from the Rio Negro till it enters the ocean, it is the river of the Amazons.

The number, length, and volume of its tributaries are in proportion to its magnitude, even the affluents of its affluents are noble streams. More than 20 superb rivers, navigable almost to their sources, pour their waters into it, and streams of less importance are numberless. Two of the largest, the Huallago and Ucayale, like their primary, rise in the plains of Bombon ; the former has its origin in the mining district of Pasco, and after a long northern course between the Cordilleras it breaks through a gorge similar to that of Manse-riche, and joins the Marañon in the plains: it is almost a mile broad above its junction. The Spanish Governor of Peru sent Pedro de Ursoa down this river, in the year 1560, to search for the lake of Parima, and the city of El Dorado. The Ucayale, not inferior to the Marañon itself, rises 90 miles east of the city of Lima. In a course of 1080 miles it is fed by accessories from an enormous extent of country, and at its junction with the main stream, near the mission of San Joachim de Omapuas, a line of 50 fathoms does not reach the bottom. By these streams there is access to Peru, and there is communication between the Amazons and the most distant regions around by the other navigable feeders. On the south it is connected with Bolivia and Brazil by the Beni ; and the Madiera, which is its greatest affluent, comes near the sources of the Paraguay, the principal accessory of the Rio de la Plata. The river of the Amazons is not less extensively connected on the north. The high lands of Colombia are accessible by the Putumoya, the Japura, and other great navigable rivers ; the Rio Negro, nearly nine miles broad a little way above its junction with the Amazons, unites the latter with the Orinoco by the Cassiquiare ; and lastly the sources of the Rio Branco come very near to those of the Essequibo, an independent river of Demerara.

The main stream, from its mouth, nearly throughout its



length, is full of river islands, and most of its tributaries have deltoid branches at their junction with it. The annual floods of the Amazons are less regular than those of the Orinoco, and as the two rivers are in different hemispheres, they occur at opposite seasons. The Amazons begins to rise in December, is at its greatest height in March, and its least in July and August. The quantity of rain that falls in the deep forests traversed by this river is so great, that were it not for the enormous evaporation, and the streams that carry it off, the country would be flooded annually to the depth of eight feet. The Amazons is divided into two branches at its mouth, of which one joins the Parà, south of the island of Das Joanes, the other enters the ocean to the north of it.

The water of some of the rivers in equatorial America is white ; in others it is of a deep coffee colour, or dark green, when seen in the shade, but perfectly transparent, and when ruffled by a breeze, of a vivid green, like some of the Swiss lakes. In Scotland the brown waters comes from peat mosses, but it is not so in America, as they occur as often in forests as in savannahs. Mr. Schomburgk thinks they are stained by the iron in the granite; however, the colouring matter has not been chemically ascertained. The Orinoco and the Cassiquiare are white; the Rio Negro is black, as its name implies, yet the water does not stain the rocks, which are of a dazzling white. Black waters are sometimes, though rarely, found on the table-land of the Andes.

The Rio de la Plata forms the third great water system of South America. The Rio Grande, its principal stream, rises in the mountains of Minas Geraes, in Brazil, and runs 500 miles on the table-land from N. to S., before it takes the name of Paranà. For more than 100 miles it is a continued series of cataracts and rapids, the greatest of which is the Salta Grande, about  $24^{\circ} 5' S.$  lat. Above the fall the river is three miles broad, when all at once it is confined in a rocky pass only 60 yards wide, through which it rushes over a ledge with a thunderous noise, heard at the distance of many miles. The Paranà receives three large rivers on the right; the Paraguay, the Pilcomayo, and the Vermejo, all generally tending to the south, unite at different distances before entering their primary at Corrientes. The Paraguay, 1200 miles long, is the finest of these; in its upper part it



is singularly picturesque, adorned with palms and other tropical vegetation, and its channel islands are covered with orange groves. It springs from a chain of seven lakes, in the southern slopes of the Campos Parecis, in Brazil, and may be ascended by vessels of considerable burthen through 19 degrees of latitude. The Pilcomayo and Vermejo, both come from Bolivia; the former traverses the desert of the Gran Chaco, the latter the district of Tarija. At Santa Fé the La Plata turns eastward, and before entering the Atlantic is augmented by the Uruguay from the north, which takes its name from the turbulence of its streams.

The Rio de la Plata is 2700 miles long, and for 200 miles from its mouth, up to Buenos Ayres, it never is less than 170 miles broad. Were it not for the freshness of its water, it might be mistaken for the ocean; it is, however, shallow and loaded with mud.

The Paraguay is subject to dreadful floods; in 1812 the atmosphere was poisoned by the putrid carcasses of drowned animals; the ordinary annual inundations of the Paraná, the principal or upper branch of the La Plata, cover 36,000 square miles.

In consequence of the vast extent of the very level plains along the base of the Andes, the basins of the three great rivers are apparently united. So small are the elevations that determine their direction, that, with the exception of a portage of three miles, a vessel might sail from Buenos Ayres, in 35° S. lat., to the mouth of the Orinoco, in 9° N. lat., by inland navigation.

There are various rivers in South America unconnected with those described, which in any other country would be esteemed of a high order. Of many that descend from the mountains of Parima, the Essequibo is the largest, fed by the streams of Guiana. Its general width is a mile and a quarter; its water, though black, is transparent; and on its banks, and those of all its adjuncts, the forest reigns in impenetrable thickness.

The Parà and San Francisco are the chief Brazilian rivers; both rise on the table-land: the former results from the union of the Tocantins and Araguay; it descends from the high lands in rapids in its northerly course, and after running 1500 miles joins the southern branch of the Amazons before entering the Atlantic, south of the island Das Joanes. The



San Francisco is only 1275 miles long, and after travelling northward between mountain-ranges parallel to the coast, it breaks through them, and reaches the ocean about the 11th degree S. lat. As in the Appalachian chain, so here many little rivers come down the edge of the table-land to the level maritime plains of the Atlantic.

In the far south the Rio Negro, and some other streams from the Chilian Andes, run through, but do not fertilize, the desolate plains of Patagonia.

### RIVERS OF NEW HOLLAND.

After America, the land of the river and the flood, New Holland appears in more than its usual aridity. The absence of large rivers is one of the greatest impediments to the improvement of this continent. What it may possess in the interior is not known, but it is certain that no large river discharges its water into the ocean, and most of the small ones are absorbed before they reach it.

The streams from the mountains on the eastern side of the continent are mere torrents, and would have short courses did they not run in longitudinal valleys, as, for example, the Hawkesbury. The Murumbigee, the Lachlan and McQuarrie, formed by the accumulation of mountain torrents, are the largest.

The Murumbigee rises in the ranges west of St. George's Lake, and running south-west, meets the Lachlan, of unknown origin, coming from the east. After their junction they pass through the Alexandrine Marsh, and run into the Murray, a much larger stream, though only 350 feet broad, and not more than 20 feet deep, and on entering the ocean in Endeavour Bay it is too shallow even for boats. The Darling is supposed to be merely the upper part of the Murray, probably rising towards the head of St. Vincent's Gulf. The origin of the Macquarrie is unknown: it is called the Fish River, between Bathurst and Sydney; after running 600 miles north-west, it is lost in the marshes.

Swan River, on the western side of the continent, has much the same character; and from that river to the Gulf of Carpentaria, along the whole of the western and northern shores of the continent, there are none. The want of water makes it hardly possible to explore the interior of this continent.



## CHAPTER XIX.

## LAKES—NORTHERN SYSTEM OF THE GREAT CONTINENT—MOUNTAIN SYSTEM OF THE SAME—AMERICAN LAKES.

THE hollows formed on the surface of the earth by the ground sinking or rising, earthquakes, streams of lava, the intersection of strata, and those that occur along the edges of the different formations, are generally filled with water, and constitute systems of lakes, some salt and some fresh. Many of the former may be remnants of an ancient ocean left in the depression of its bed during its retreat as the continents arose.

Almost all lakes are fed by springs in their beds, and they are occasionally the sources of the largest rivers. Some neither receive tributaries nor have outlets: the greater number do both. The quantity of water in lakes varies with the seasons everywhere, especially from the melting snow on mountain-chains and high latitudes, and between the tropics from periodical rains. Small lakes occur in mountain passes, formed by water which runs into them from the commanding peaks: they are frequently, as in the Alps, very transparent, of a bright green or azure hue. Large lakes are common on table-lands and in the valleys of mountainous countries, but the largest are on extensive plains. The basin of a lake comprehends all the land drained by it; consequently it is bounded by an imaginary line passing through the sources of all the waters that fall into it.

There are more lakes in high than in low latitudes, and in this respect there is a great analogy between the northern plains of the two principal continents. Sheets of water of great beauty occur in the mountain valleys of the British Islands, of Norway and Sweden, countries similar in geological structure; and besides these, there are two regions in the old world in which lakes particularly abound. One begins in the low coast of Holland, goes round the southern and eastern sides of the Baltic, often passing close to its shores, along the Gulf of Bothnia, and through the Siberian plains to Behring's Straits. The lakes which cover Finland, and the great



lakes of Ladoga and Onega, lie in a parallel direction: they occupy transverse rents which had taken place across the palæozoic strata while rising in a direction from S.W. to N.E. between the Gulf of Finland and the White Sea; that elevation was perhaps also the cause of the cavities now occupied by these two seas. Ladoga is the largest lake in this zone, having a surface of nearly 1000 square miles. It receives tributary streams and sends off its superfluous water by rivers, and Onega does the same; but the multitude of small steppe lakes among the Ural Mountains and in the basin of the river Obi neither receive nor emit rivers, being for the most part mere ponds, though of great size, some of fresh, some of salt water, lying close together, a circumstance which has not been accounted for; the lakes in the low Siberian plains have the same character.

The second system of lakes in the old continent follows the zone of the mountain mass, and comprehends those of the Pyrenees, Alps, Apennines, Asia Minor, the Caspian, the lake of Aral, together with those on the table-land and in the mountains of central Asia.

In the Pyrenees lakes are most frequent on the French side; many are at such altitudes as to be perpetually frozen: one on Monte Perdido, 8393 feet above the sea, has the appearance of an ancient volcanic crater. There is scarcely a valley in the Alpine range and its offsets that has not a sheet of water, no doubt owing to the cavities formed during the elevation of the ridges, and in some instances to subsidence of the soil. There are more lakes on the north than on the south side of the Alps—the German valleys are full of them. In Bohemia, Galicia, and Moravia, there are no less than 30,000 sheets of water, besides great numbers throughout the Austrian empire.

Of the principal lakes on the northern side of the Alps, the lake of Geneva, or lake Lemán, is the most beautiful, from its situation, the pure azure of its waters, and the sublime mountains that surround it. Its area, of about 100 square miles, is 1150 feet above the sea, and at Meillerie it is 1000 feet deep. The lake of Lucerne is 1400 feet above the sea, and the lake of Brienz 1900 feet. The Italian Alpine lakes are at a lower level: the Lago Maggiore has only 678 feet of absolute altitude: they are larger than those in the north, and with the advantages of an Italian climate, sky, and vege-



tation, they surpass the others in beauty, though the mountains that surround them are less lofty.

These great lakes are fed by streams from glaciers in the higher Alps, and many large rivers issue from them. In this respect they differ from most of the lakes in lower Italy, which, with few exceptions, are craters of ancient volcanoes, or perhaps ancient craters of elevation, where the earth had been swelled up by subterranean vapour without bursting, and had sunk down again into a hollow when the internal pressure was removed.

In Syria, the lake of Tiberias and the Dead Sea, sacred memorials to the Christian world, are situate in the deepest cavity on the earth. The surface of the former, 466 feet below the level of the Mediterranean, is adorned with verdant plains and aromatic shrubs; while the heavy, bitter waters of the Dead Sea, 1312 feet below the same level, is a scene of indescribable desolation and solitude, encompassed by desert sands, and bleak, stony salt-hills. Thus there is a difference of level of 1000 feet in little more than 60 miles, which makes the course of the Jordan very rapid. The water of the Dead Sea is so acrid that it irritates the skin; and as it contains 26·24 per cent. of chlorides, it is more buoyant, and contains a greater proportion of salt, than any that is known, except the small lake of Elton, east of the Volga.

Though extensive sheets of water exist in many parts of Asia Minor, especially in Bithynia, yet the characteristic feature of that country, and of all the table-land of Western Asia and the adjacent steppes, is the number and magnitude of the saline lakes. A region of salt lakes and marshes extends at least 200 miles along the northern foot of the Taurus range, on a very elevated part of the table-land of Anatolia. There are also many detached lakes, some exceedingly saline. Fish cannot live in the lake of Toozla, and if a bird dips its wings in the water, they are incrustated with salt on drying: it is shallow and subject to excessive evaporation. Neither can any animal exist in the lake of Shahee or Urmiah, on the confines of Persia and Armenia, 300 miles in circumference: its water is perfectly clear, and contains a fourth part of its weight of saline matter. These lakes are fed by springs, rain, and melted snow, and having no emissaries, the surplus water is carried off by evaporation.

It is possible that the volcanic soil of the table-land may



be the cause of this exuberance of salt water; yet there are many fresh-water lakes in their immediate vicinity. Lake Van, a sheet of fresh water, 240 miles in circumference, is separated from the salt lake Urmiah only by a range of hills, and there are many other pieces of fresh water in that neighbourhood.

Persia is singularly destitute of water: the lake of Zorah, on the frontiers of Afghanistan, having an area of 18 square miles, is the only piece of water on the western part of the table-land of Iran.

It is evident, from the saline nature of the soil and the shells it contains, that the plains round the Caspian, the lake of Aral, and the steppes, even to the Ural Mountains, had once formed part of the Black Sea. 57,000 square miles of that country are depressed below the level of the ocean, a depression which extends northwards beyond the town of Saratov, 300 miles distant from the Caspian. The surface of the Caspian itself, which is 83·6 feet below the level of the ocean, is its lowest part, and has an area of 18,000 square miles, nearly equal to the area of Spain. In Europe alone it drains an extent of 850,000 square miles, receiving the Volga, the Ural, and other great rivers on the north. It has no tide, and its navigation is dangerous from heavy gales, especially from the S.E., which drive the water miles over the land: a vessel was stranded 46 miles inland from the shore. It is 600 feet deep to the south, but is shallower to the east, where it is bounded by impassable swamps many miles broad. The lake Elton, on the steppe east of the Volga, has an area of 130 square miles, and furnishes two-thirds of the salt consumed in Russia. Its water yields 29·13 per cent. of solid matter, while the water of the Dead Sea has 26·24 per cent. of saline ingredients; but it contains sulphate of magnesia, whereas Lake Elton has chloride of calcium.

The lake of Aral, which is shallow, is higher than the Caspian, and has an area of 3372 square miles. It has its name from the number of small islands at its southern end, Aral signifying "island" in the Tartar language. Neither the Caspian nor the lake of Aral have any outlets; though they receive large rivers, they, and all the lakes in Persia, are decreasing in extent and becoming more salt, the quantity of water supplied by tributaries being less than that lost by evaporation.



Most of the rivers that are tributary to the lake of Aral are diminished by canals that carry off water for irrigation ; for that reason the Oxus never reaches the lake. Besides, the Russian rivers yield less water than formerly, from the progress of culture.

The absence of lakes in the Himalaya is one of the peculiarities of these mountains. The lake of Ular, in the valley of Cashmere, is the only one of any magnitude : it is but 40 miles in circumference, and seems to be the residue of one that had filled the whole valley at some early period. There are many great lakes, both fresh and salt, in the table-land : the annular form of Lake Palte, at the northern base of the Himalaya, is unexampled, and the height of the sacred lake of Manasa, in Great Tibet, is equally so, being 17,000 feet above the level of the sea. Tibet is full of lakes, many of which produce borax, found nowhere else but in Tuscany and the Lipari Islands. As most of the great lakes on the table-land are in the Chinese territories, strangers have not had access to them ; but the Koko-nor and Lake Lop seem to be very large ; the latter is said to have a surface of 2187 square miles, and there are others not inferior to it in the north. The lakes in the Altaï are beautiful, larger, and more numerous than in any other mountain-chain. They are at different elevations on the terraces by which the table-land descends to the flats of Siberia, and are, owing to geological phenomena, essentially different from those which have produced the Caspian and other steppe lakes. They seem to have been hollows formed where the axes of the different branches of the chain cross, and are most numerous and deepest in the eastern Altaï. Baikal, the largest mountain lake, supposed to owe its origin to the sinking of the ground during an earthquake, has an area of 14,800 square miles, nearly equal to the half of Scotland. It lies buried in the form of a crescent amid lofty granite mountains which constitute the edge of the table-land to the south, ending in the desert of the Great Gobi, and in the north-west they gird the shore so closely that they dip into the water in many places : 160 rivers and streams are tributary to this salt lake, which drains a country probably twice the size of Britain. The river Angara, which runs deep and strong through a crevice at its eastern end, is its principal outlet, and is supposed to carry off but a small proportion of its water. Its surface is 1793



feet above the sea-level, and the climate is as severe as it is in Europe  $10^{\circ}$  farther north, yet the lake does not freeze till the middle of December, possibly from being unfathomable with a line 600 feet long.

Two hundred and eighty years before the Christian era the large fresh-water lake of Oitz, in Japan, was formed in one night by a prodigious sinking of the ground, at the same time that one of the highest and most active volcanoes in that country rose from the depths of the earth.

Very extensive lakes occur in Africa, and notwithstanding the arid soil of the southern table-land, it contains the fresh-water lake of N'yassi, one of the largest, being some hundred miles long, and though narrow in proportion, it cannot be crossed in a boat of the country in less than three days, resting at night on an island, of which there are many. It begins 200 miles north from the town of Tete, on the river Zambeze, and extends from south-east to north-west to a very great but unknown distance, and between 300 and 400 miles from the Mozambique channel. No river is known to flow out of it, but it receives the drainage of the country on the south-west. No one knows what there may be on the unexplored regions of the Ethiopian desert, but Abyssinia has the large and beautiful lake of Dembea, situate in a spacious plain, the granary of the country, and so high above the sea, that spring is perpetual, though within the tropics. There are other lakes in this great projecting promontory so full of rivers, mountains, and forests, but the low lands of Soudan, the country lying along the base of the Mountains of the Moon, in the principal region of African lakes, of which the Chad, almost the size of an inland sea, is in the very centre of the continent. Its extent, and the size of its basin, are unknown, but it receives many affluents from the Mountains of the Moon, and is itself drained by the Chadda, a principal tributary of the Niger. Other lakes of less magnitude are known to exist in these regions, and there are probably many more that are unknown. Salt-water lakes are numerous on the northern boundaries of the great lowland deserts, and many fine sheets of fresh water are found in the valleys and flat terraces of the Great and Little Atlas.

Fresh-water lakes are characteristic of the higher latitudes of both continents, but those in the old continent sink into insignificance in comparison with the number and extent of



those in the new. Indeed a very large portion of North America is covered with fresh water; the five principal lakes, Superior, Huron, Michigan, Erie, and Ontario, with some of their dependents, probably cover an area of 100,000 square miles, that of Lake Superior alone 43,000, which is only 7000 square miles less than the whole of England. The American lakes contain more than half the amount of fresh water on the globe. The altitude of these lakes shows the slope of the continent: the absolute elevation of Lake Superior is 627 feet, Lake Huron is 30 feet lower, Lake Erie 32 feet lower than the Huron, and Lake Ontario is 331 feet below the level of Erie. The river Niagara, which unites these two last lakes, is  $33\frac{1}{2}$  miles long, and in that distance it descends 66 feet; it falls in rapids through 55 feet of that height in the last half-mile, but the upper part of its course is navigable. The height of the cascade of Niagara is 162 feet on the American side of the central island, and 1125 feet wide. On the Canadian side the fall is 149 feet high, and 2100 feet wide—the most magnificent sheet of falling water known, though many are higher. The river St. Lawrence, which drains the whole, slopes 234 feet between the bottom of the cascade and the sea. The beds of lakes Superior and Ontario are respectively 165 and 336 feet below the surface of the Atlantic, affording another instance of deep indentation in the solid matter of the globe. Some lakes are decreasing in magnitude, but the contrary seems to be the case in America; between the years 1825 and 1838 Ontario rose nearly seven feet, and according to the American engineers Lake Erie had gained several feet in the same time. Lake Huron is said to be the focus of peculiar electrical phenomena, as thunder is constantly heard in one of its bays. The lakes north of this group are innumerable: the whole country, to the Arctic Ocean, is covered with sheets of water which emit rivers and streams. Lake Winnipeg, Rein-deer Lake, Slave Lake, and some others, may be regarded as the chief members of separate groups or basins, each embracing a wide extent of country almost unknown. There are also many lakes on each side of the Rocky Mountains, and in Mexico there are six or seven lakes of considerable size, though not to be compared with those in North America; the largest is the lake of Tezcucó, on the west bank of which the city of Mexico is built.



There are various sheets of water in Central America, but only two of any magnitude, namely, Lake Izaval, out of which the Rio Dulce flows into the Gulf of Mexico, and the lake of Nicaragua, in the province of that name, about 100 miles from the sea of the Antilles.

In Central America the Andes are interrupted by plains and mere hills on the Isthmus of Tehuantepec and that of Panama, on each of which there is a series of lakes and rivers, which, aided by canals, might form a water communication between the Atlantic and Pacific oceans. In the former the line proposed would connect the river Huasacula, on the Gulf of Mexico, with the bay of Tehuantepec, in the Pacific. In the Isthmus of Panama, the Gulf of St. Juan would be connected, by the river of that name and the large lake of Nicaragua, with the Gulf of Costa Rica. Here the watershed is only 615 feet above the sea, and of easy excavation, and the lake, situated in an extensive plain, is deep enough for vessels of considerable size.

A range of lakes goes along the eastern base of the Andes, but the greater part of them are mere lagoons or marshes; some very large, which inundate the country to a great extent in the tropical rains. There appears to be a deep hollow in the surface of the earth at the part where Bolivia, Brazil, and Paraguay meet, in which lies the Lake Xaragas, extending on each side of the river Paraguay, but, like many South American lakes, it is not permanent, being alternately inundated and dry, or a marsh. Its inundations cover 36,000 square miles. Salt and fresh-water lakes are numerous on the plains of La Plata, and near the Andes in Patagonia, resembling in this respect those in high northern latitudes, though on a narrower scale.

In the elevated mountain-valleys and table-lands of the Andes there are many small lakes of the purest blue and green colours, intensely cold, being mostly above the line of perpetual congelation. They are generally lifeless and unfathomably deep, probably the craters of extinct volcanoes. The lake of Titicaca, however, in the Bolivian Andes, has an area of 4600 square miles, and is more than 120 fathoms deep, surrounded by splendid scenery. Though 12,795 feet above the level of the Pacific, its banks are clothed with turf where they are not cultivated, and in former times were the seat of advanced civilization, to which the ruins bear testimony.



The limpid transparency of the water in lakes, especially in mountainous countries, is remarkable; minute objects are visible at the bottom, through many fathoms of water. The vivid green tints, so often observed in alpine lakes, may be produced by vegetable dyes dissolved in the water, though chemical analysis has not detected them.

Lakes, being the sources of some of the largest rivers, are of great importance for inland navigation, as well as for irrigation; while by their constant evaporation they maintain the supply of humidity in the atmosphere, so essential to vegetation, besides the embellishment a country derives from their limpid and glassy waters.

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## CHAPTER XX.

### THE ATMOSPHERE.

THE annual supply of heat which the earth receives from the sun is always the same, and it is annually radiated into space, so that it neither accumulates in the earth nor in the atmosphere. Its distribution is very unequal, but certain it is that an excess of heat in one part of the globe is compensated by a deficiency in another; an unusually warm summer is balanced by a cold one elsewhere. Diurnal variations of heat are perceptible only at a small distance below the surface, because the earth is a bad conductor, the annual heating influence of the sun penetrates much deeper. The heat which enters the earth in summer, returns during winter; and before passing into space, tempers the cold in the higher latitudes. At the equator, where the heat is the greatest, it descends deeper than elsewhere, with a diminishing intensity; but there, and everywhere throughout the globe, there is a stratum, at the depth of from 40 to 100 feet below the surface of the ground, where the temperature never varies, and is nearly the same with the mean heat of the surface.

At least one-third of the sun's heat is absorbed by the air before reaching the earth, but the atmosphere is chiefly warmed by the radiation of the sun's heat from the earth in its return to space, which takes place most abundantly when



the sky is clear and blue. It is intercepted by clouds, so that a thermometer rises in cloudy weather, and sinks when the air becomes clear and calm; even a slight mist diminishes radiation from the earth, because it returns as much heat as it receives.

The superficial temperature of the earth is great at the equator, it decreases gradually towards the poles, and is an exact mean between the two at the 45th parallel of latitude; but a multitude of causes disturb this law. It is affected chiefly by the unequal distribution of land and water, by the height above the sea, by the nature of the soil, and by vegetation, so that a line drawn on a map through all the places where the mean temperature of the earth is the same, would be very far from coinciding with the parallels of latitude, but would approximate more to them near the equator.

Every thing that lives on earth depends upon the atmosphere, the source of life and heat to animated nature. The air, being a heavy and elastic fluid, decreases in density upwards according to a determinate law, so rapidly that three-fourths of it are within four miles of the earth, and all the meteoric phenomena perceptible to us, as clouds, rain, heat, and thunder, occur in that space, though the height of the atmosphere is about 50 miles. The actual pressure of the atmosphere is about 15 pounds on every square inch, diminishing of course with the height. The density is liable to continual changes from the temperature, and the attraction of the sun and moon, which produce tides similar to those in the ocean. All these changes are responded to by variations in the height of the barometer.

The air expands and becomes lighter with heat, and contracts and becomes heavier with cold; hence at the equator, where the sun is so powerful, the light warm air is constantly ascending to the upper regions of the atmosphere, and flowing north and south towards the poles, from whence the cold heavy air rushes along the surface of the earth to supply its place between the tropics, for the same tendency to restore equilibrium exists in the air as in other fluids. The two superficial currents are relatively deflected from their meridional directions by the rotation of the earth, so that the northern current becomes a north-east wind before arriving at the tropic of Cancer, and the southern current becomes a south-east wind before it comes to the tropic of



Capricorn. At the equator they so completely neutralize each other, that far at sea a candle burns without flickering. In fact, the difference of temperature puts the air in motion, and the direction of the resulting wind at every place depends upon the difference between the rotatory motion of the wind and the rotatory motion of the earth—the whole theory of the winds depends upon these circumstances.

The trade-winds and monsoons are permanent, depending on the apparent motion of the sun; but it is evident, from theory, that there must be partial winds in all parts of the earth, occasioned by local circumstances that affect the temperature of the air; consequently the atmosphere is divided into districts both over the sea and land, in which the winds have nearly the same vicissitudes from year to year, and the regularity is greatest towards the tropics, where the causes of disturbance are fewer. In the higher latitudes it is more difficult to discover any regularity, on account of the greater proportion of land, the difference in its radiating power, and the greater extremes of heat and cold. But even there a degree of uniformity prevails in the succession of the winds. For example, in all places where north and south winds blow alternately, a vane veers through every point of the compass in the transition, and in some places the wind makes several of these gyrations in the course of the year. The south-westerly winds, so prevalent in the Atlantic Ocean between the 30th and 60th degrees of north latitude, are produced by the upper current being driven down to supply the superficial current which goes towards the equator; and as it has a greater rotatory motion than the earth in these latitudes, it produces a south-westerly wind. North-westerly winds prevail in the corresponding latitudes of the southern hemisphere from the same cause. In fact, whenever the air has a greater velocity of rotation than the surface of the earth, a wind more or less westerly is produced, and, when it has less velocity of rotation than the earth, a wind having an easterly tendency results. Thus there is a perpetual exchange between the different masses of the atmosphere, the warm air tempering the cold of the higher latitudes, and the cold air mitigating the heat of the lower; it will be shown afterwards that the aërial currents are the bearers of principles on which the life of the animal and vegetable world depends. The trade-winds, being constant,



are essentially connected with an equatorial permanent depression in the barometer, but the mercurial column varies in every other part of the globe with a change in the density of the air and the resulting wind ; indeed, the barometer gives the surest indication of an approaching change, often warning the mariner of the gale long ere it takes place. Here it may truly be said that "coming events cast their shadows before."

Since the atmosphere is chiefly warmed by heat transmitted from the earth, the temperature of the air decreases as the height above the earth increases, so that at a very small elevation the cold becomes excessive, as on the tops of mountains. This circumstance is marked by the line of perpetual snow, which is subject to many variations, but on the mountains under the equator it has a mean height of 15,207 feet, from whence it diminishes on both sides, and at last grazes the surface at the arctic and antarctic circles.

The mean annual temperature of the air would be constant on each parallel of latitude, and would decrease regularly from the equator to the poles, were it not for the inequalities in the form and nature of the surface of the globe. But these causes of disturbance are so great that lines drawn on a map through all places having the same mean annual temperature are exceedingly irregular, except towards the equator, where they become nearly parallel to it. As the air receives most of its warmth from the earth, radiation is the principal cause of disturbance ; hence the temperature is most powerfully modified by the ocean, which occupies three times as much of the surface of the globe as the land, and is more uniform in its surface, and also in radiating power. On land, the difference in the radiating force of the mountains and tablelands from that of the plains, of the deserts from grounds covered with rich vegetation, of the wet land from the dry, is the most general cause of variation ; the local causes are beyond enumeration.

Places having the same mean annual temperature often differ materially in climate ; in one the winters are mild and the summers cool, whereas in others the extremes of heat and cold prevail : England is an example of the first ; Quebec, Petersburg, and the arctic lands are instances of the latter. It follows, as a consequence of the same quantity of heat being received annually from the sun, and annually



radiated into space, that all the climates of the earth are stable, and that the vicissitudes are merely cycles that vanish after a few years. It is possible, however, that the earth may be affected by secular changes of temperature during the progress of the solar system through space.

Moisture is evaporated in an invisible form from every part of the land and water, but in very different quantities. Seven-tenths of the atmosphere rest on the ocean, therefore the sea has the greatest influence in modifying the climates on the land and supplying the air with moisture. The evaporation is greatest between the tropics, from the excess of heat, the preponderance of the ocean, and the rankness of vegetation. The average quantity of vapour decreases from the equator to the poles, and from the lower to the higher part of the atmosphere. The absolute quantity is very partial and irregular, depending everywhere on the dryness or humidity of the surface. As the vapour ascends in the atmosphere, it maintains its invisible form till it reaches a stratum of air of lower temperature, when it is condensed into clouds, and is thence precipitated in the form of rain, hail, or snow. Its dispersion and condensation are owing to the winds, the great agents in all atmospheric changes. From friction and other causes, the currents of air in the lower parts of the atmosphere run on each other horizontally; and as they generally differ in moisture, temperature, and velocity, to them is due the formation of clouds, rain, and the generation of electricity. When two masses of air of different temperatures meet, the colder, by absorbing the heat which holds the moisture in solution, occasions the particles to coalesce and form drops of water, which fall by their gravitation; and when two strata of air of different temperatures, moving rapidly in opposite directions, come into contact, an abundant fall of rain is the consequence, and, as in tropical countries the quantity of aqueous vapour is greatest, the rain-drops are largest, and the rain heaviest.

The atmosphere, when clear, is almost always positively electric. The electricity arises from evaporation and the chemical changes which are perpetually in progress all over the globe; and as they sometimes generate positive and sometimes negative electricity, they occasion great local variations in the electricity of the air, but the earth itself is always in a negative state. It has been considered by some



meteorologists that clouds owe their form to the electric fluid, because, when two strata of air are of different temperatures, and move in different directions, a portion of their aqueous vapour is deposited, and the electricity evolved is taken up by the remaining vapour, which causes it to assume the form of a cloud. Electricity of each kind is probably elicited by the friction of streams of air moving rapidly in different directions, and when clouds differently charged meet a storm ensues. Hail is formed when two masses of air of very different temperatures meet suddenly; hence hail is rare in tropical countries, except near mountains. The quantity of electricity in the earth and atmosphere is very great; it is constantly varying, and performs a very important part in animal and vegetable life.

Magnetism, which pervades the whole earth, is identical with electricity, although it never comes naturally into evidence. The brilliant experiments of Dr. Faraday give a new view of the magnetic condition of the substances on the surface of the globe. He found that ten of the metals are more or less magnetic, that is to say, they possess the power of attracting either pole of a magnet, and bars of these metals freely suspended between the poles of an electric magnet assume a position in the axis or line of the magnetic force, but all other substances whatever under the same circumstances are repelled by both poles of the electric magnet, and take a position at right angles to the line of current of the magnetic force. The same effect, though less powerful, was produced by a steel horse-shoe magnet. All substances are thus either magnetic or diamagnetic, except air and the gases, which are neutral. Of the metals 10 are magnetic and 16 diamagnetic: iron and bismuth are the extremes of these two conditions of matter. The inferences drawn from these discoveries by Dr. Faraday are very important: "When we consider the magnetic condition of the earth, as a whole, without reference to its possible relation to the sun, and reflect upon the enormous amount of diamagnetic matter which forms its crust, and when we remember that magnetic curves of a certain amount of force, and universal in their presence, are passing through these matters, and keeping them constantly in that state of tension, and therefore of action, we cannot doubt but that some great purpose of utility to the system, and to us its inhabitants, is thereby



fulfilled." "It is curious to see a piece of wood, or leaf, or an apple, or a bottle of water, repelled by a magnet, or the leaf of a tree taking an equatorial position. Whether any similar effects occur among the myriads of forms which in all parts of the earth's surface are surrounded by air, and subject to the action of lines of magnetic force, is a question which only can be answered by future observations. If the sun have any thing to do with the magnetism of the globe, then it is probable that part of this effect is due to the action of the light that comes to us from it, and in that view the air seems most strikingly placed round our sphere, investing it with a transparent diamagnetic, which therefore is permeable to his rays, and at the same time moving with great velocity across them. Such conditions seem to suggest the possibility of magnetism being thence generated." Dr. Faraday's discoveries go still farther; having magnetised and electrified a ray of light, he has added another proof of the identity of these two powers. If a ray of polarized light be transmitted through certain transparent substances placed in the line of force connecting the opposite poles of an electro-magnet, it is so affected by this power that it becomes visible or invisible according as the current is flowing or not at the moment, this influence being more complete as the ray of light is more nearly parallel to the line of magnetic force, ceasing if it is perpendicular to it. The very same effect was produced with a steel horse-shoe magnet, though more feeble in degree. Mr. Christie has proved that magnetism has an influence on light direct from the sun.\*

Atmospheric air is principally a mixture of oxygen and azotic gas: of 100 parts of air, 21 are oxygen gas, the source of life and heat to the animal and vegetable kingdoms; the other 79 parts are azote, or nitrogen. Besides these chief ingredients the air contains a very small quantity of ammonia, water in an invisible state, and a tenth per cent. of carbonic acid gas. The existence of the vegetable world depends upon these constituents.

\* See the 7th edition of the "Connection of Physical Sciences: on Polarized Light and Terrestrial Magnetism."



## CHAPTER XXI.

VEGETATION—THE NOURISHMENT AND GROWTH OF PLANTS—  
CLASSES—BOTANICAL DISTRICTS.

IN the present state of the globe a third part of its surface only is occupied by land, and probably not more than a fourth part of that is inhabited by man, but animals and vegetables have a wider range. The greater part of the land is clothed with vegetation and inhabited by quadrupeds, the air is peopled with birds and insects, and the sea teems with living creatures and plants. These organized beings are not scattered promiscuously, but all classes of them have been originally placed in regions suited to their respective wants. Many single animals and plants are indigenous only in determinate spots, while a thousand others might have supported them as well, and to many of which they have been transported by man.

The atmosphere supplies the vegetable creation with the principal part of its food ; plants extract inorganic substances from the ground, which are indispensable to bring them to maturity.

The black or brown mould, which is so abundant, is the produce of decayed vegetables. When the autumnal leaves, the spoil of the summer, fall to the ground, and their vitality is gone, they enter into combination with the oxygen of the atmosphere, and convert it into an equal volume of carbonic acid gas, which consequently exists abundantly in every good soil, and is the most important part of the food of vegetables. This process is slow, and stops as soon as the air in the soil is exhausted ; but the plough, by loosening the earth, and permitting the atmosphere to enter more freely, and penetrate deeper into the ground, accelerates the decomposition of the vegetable matter, and consequently the formation of carbonic acid.

In loosening and refining the mould, the common earth-worm is the fellow-labourer with man ; it eats earth, and, after extracting the nutritious part, ejects the refuse, which is the



finest soil, and may be seen lying in heaps at the mouth of its burrow. So instrumental is this reptile in preparing the ground, that it is said there is not a particle of the finer vegetable mould that has not passed through the intestines of a worm; thus the most feeble of living creatures is employed by Providence to accomplish the most important ends.

The food of the vegetable creation consists of carbon, hydrogen, nitrogen, and oxygen, all of which plants obtain entirely from the atmosphere, in the form of carbonic acid gas, water, and ammonia. They imbibe these three substances, and, after having decomposed them, they give back the oxygen to the air, and consolidate the carbon, water, and nitrogen into wood, leaves, flowers, and fruit.

The vitality of plants is a chemical process, entirely due to the sun's light; it is most active in clear sunshine, feeble in the shade, and nearly suspended in the night, when plants, like animals, have rest.

The atmosphere contains only one-tenth per cent. of carbonic acid gas, yet that small quantity yields enough of carbon to form the solid mass of all the magnificent forests and herbs that clothe the face of the earth, and would soon be exhausted, were it not renewed by the breath of animals, by volcanoes and mineral springs, and by combustion. The green parts of plants constantly imbibe carbonic acid in the day; they decompose it, assimilate the carbon, and return the oxygen pure to the atmosphere. As the chemical action is feeble in the shade and in gloomy weather, only a part of the carbonic acid is decomposed, and then both oxygen and carbonic acid are given out by the leaves; but during the darkness of night a chemical action of a different character takes place, and almost all the carbonic acid is returned unchanged to the atmosphere, together with the moisture that is evaporated from the leaves both night and day. Thus, plants give out pure oxygen during the day, and carbonic acid and water during the night.

Since the vivifying action of the sun brings about all these changes, a superabundance of oxygen is exhaled by the tropical vegetation in a clear unclouded sky, where the sun's rays are most energetic, and atmospheric moisture most abundant. In the middle and higher latitudes, on the contrary, under a more feeble sun, and a gloomy sky subject to rain, snow, and frequent atmospheric changes, carbonic acid is



given out in greater quantity by the less vigorous vegetation. But here, as with regard to heat and moisture, equilibrium is restored by the winds: the tropical currents carry the excess of oxygen along the upper strata of the atmosphere to higher latitudes, to give breath and heat to men and animals; while the polar currents, rushing along the ground, convey the surplus carbonic acid to feed the tropical forests and jungles. Harmony exists between the animal and vegetable creations: animals consume the oxygen of the atmosphere, which is restored by the exhalation of plants, while plants consume the carbonic acid exhaled by men and animals: the existence of each is thus due to their reciprocal dependence. Few of the great cosmical phenomena have only one end to fulfil; they are the ministers of the manifold designs of Providence.

When a seed is thrown into the ground the vital principle is developed by heat and moisture, and part of the substance of the seed is formed into roots, which suck up water mixed with carbonic acid from the soil, decompose it, and consolidate the carbon. In this stage of their growth plants derive their whole sustenance from the ground. As soon, however, as the sugar and mucilage of the seed appear above the ground, in the form of leaves or shoots, they absorb and decompose the carbonic acid of the atmosphere, retain the carbon for their food, and give out the oxygen in the day, and pure carbonic acid in the night. In proportion as plants grow, they derive more of their food from the air and less from the soil, till their fruit is ripened, and then their whole nourishment is derived from the atmosphere. Trees are fed from the air, after their fruit is ripe, till their leaves fall; annuals, till they die. Air-plants derive all their food from the atmosphere. The cactus *semper vivens* and the sedum *semper vivens*, which are attached to the ground only by a point, also succulent and milky-juiced plants which grow in barren ground, are almost entirely fed from the air, and even forests sometimes grow on land destitute of carbon. It is wonderful that so small a quantity of carbonic acid as exists in the air should suffice to supply the whole vegetation of the world.

Plants absorb water from the ground by their roots, they decompose it, and the hydrogen combines in different proportions with their carbonic acid to form wood, sugar, starch, gum, vegetable oils, and acids. As the green parts of plants



combine with the oxygen of the air, especially during night, when the functions of plants are torpid, it is assimilated on the return of daylight, and assists in forming oils, resins, and acids. The combination of the oxygen of the air with the leaves, and also with the blossom and fruit, during night, is quite unconnected with the vital process, as it is the same in dead plants. An acid exists in the juice of every plant, generally in combination with an alkali. It must be observed however, that these different substances are produced at different stages in the growth; for example, starch is formed in the roots, wood, stalks, and seeds, but it is converted into sugar as the fruit ripens, and the more starch the sweeter the fruit becomes. Most of these new compounds are formed between the flowering of the plant and the ripening of the fruit, and indeed they furnish the materials for the flowers, fruit, and seeds.

Ammonia, the third organic constituent of plants, is the last residue from the decay and putrefaction of animal matter. It is volatilized, and rises into the atmosphere, where it exists as a gas, but in so small a quantity that it cannot be detected by chemical analysis; yet, as it is very soluble in water, enough is brought to the ground by rain to supply the vegetable world. Ammonia enters plants by their roots along with rain-water, and is resolved within them into its constituent elements, hydrogen and nitrogen. The hydrogen aids in forming the wood, acids, and other substances before mentioned; while the nitrogen enters into every part of the plant, and forms new compounds: it exists in the blossom and fruit before it is ripe, and in the wood as albumen; it also forms gluten, which is the nutritious part of wheat, barley, oats, and all other cerealia, as well as of esculent roots, as potatoes, beet-root, &c. Nitrogen exists abundantly in peas, beans, and pulse of every kind; quinine, morphia, and other substances, are compounds of it; in short, a plant may grow without ammonia, but it cannot produce seed or fruit: the use of animal manure is to supply plants with this essential article of their food.

Thus the decomposition and consolidation of the elementary food of plants, the formation of the green parts, the exhalation of moisture by their leaves, its absorption by their roots, and all the other circumstances of vegetable life, are owing to the illuminating power of the sun. Heat can be



supplied artificially in our northern climates, but it is impossible to replace the dazzling splendour of a southern sun. His illuminating influence is displayed in a remarkable degree by the *cacalia ficoides*: its leaves combine with the oxygen of the atmosphere during the night, and are as sour as sorrel in the morning; as the sun rises they gradually lose their oxygen, and are tasteless by noon; and by the continued action of the light they lose more and more, till towards evening they become bitter.

The blue rays of the solar spectrum have most effect on the germination of seed; the yellow rays, which are the most luminous, on the growing plant. In spring and summer the oxygen taken in by the green leaves in the night aids in the formation of oils, acids, and the other parts that contain it; but as soon as autumn comes, the vitality or chemical action of vegetables is weakened, and the oxygen, no longer given out in the day, though still taken in during the night, becomes a minister of destruction; it changes the colour of the leaves, and consumes them when they fall. Nitrogen, so essential during the life of plants, also resumes its chemical character when they die, and by its escape hastens their decay.

Although the food which constitutes the mass of plants is derived principally from water, and the gases of the atmosphere, fixed substances are also requisite for their growth and perfection, and these they obtain from the earth by their roots. The inorganic matters are the alkalis, phosphates, silica, sulphur, iron, and others.

It has already been mentioned that vegetable acids are found in the juices of all the families of plants. They generally are in combination with one or other of the alkaline substances, as lime, soda, potash, and magnesia, which are as essential to the existence of plants as the carbonic acid by which these acids are formed: for example, vines have potash; plants used as dyes never give vivid colours without it; all leguminous plants require it, and only grow naturally on ground that contains it. None of the corn tribe can produce perfect seeds unless they have both potash and phosphate of magnesia: nor can they or any of the grasses thrive without silica, which gives the hard coating to straw, to the beard of wheat and barley, to grass, canes, and bamboos; it is even found in solid lumps in the hollows and joints of



cane, known in India by the name of tabashir. To bring the cerealia to perfection, it is indispensable that in their growth they should be supplied with carbonic acid for the stalk, silica to give it strength and firmness, and nitrogen for the grain.

Phosphoric acid is found in the ashes of all vegetables, and is essential to many. Pulse contain but little of it, and on that account are less nutritious than the cerealia. The cruciform family, as cabbages, turnips, mustard, &c., must have sulphur in addition to the substances common to the growth of all plants: each particular tribe has its own peculiarities, and requires a combination suited to it.

The ocean furnishes some of the matters found in plants; the prodigious quantity of sea-water constantly evaporated carries with it salt in a volatilized state, which, dispersed over the land by the wind, supplies the ground with salt and the other ingredients of sea-water. The inorganic matters which enter plants by their roots are carried by the sap to every part of the vegetable system. The roots imbibe all liquids presented to them indiscriminately, but they retain only the substances they require at the various stages of their growth, and throw out such parts as are useless, together with the effete or dead matter remaining after the nutriment has been extracted from it. Plants, like animals, may be poisoned, but the power they have of expelling deleterious substances by their roots generally restores them to health. The feculent matter injures the soil; besides, after a time the ground is drained of the inorganic matter requisite for any one kind of plant; hence the necessity for a change or rotation of crops.

A quantity of heat is set free and also becomes latent in the various transmutations that take place in the interior of plants; so that they, like the animal creation, have a tendency to a temperature of their own, independent of external circumstances.

The quantity of electricity requisite to resolve a grain weight of water into its elementary oxygen and hydrogen is equal to the quantity of atmospheric electricity which is active in a very powerful thunder-storm; hence some idea may be formed of the intense energy exerted by the vegetable creation in the decomposition of the vast mass of water and other matters necessary for its sustenance. But there must



be a compensation in the consolidation of the vegetable food, otherwise a tremendous quantity would be in perpetual activity. Possibly some part of the atmospheric electricity may be ascribed to this cause; but there is reason to believe that electricity, excited by the power of solar light, constitutes the chemical vitality of vegetation.

The colouring matter of flowers is various, if we may judge from the effect which the solar spectrum has upon their expressed juices. The colour is very brilliant on the tops of mountains and in the Arctic lands. Possibly the diminished weight of the air may have some effect, for it can scarcely be supposed that barometrical changes should be entirely without influence on vegetation.

The perfume of flowers and leaves is owing to a volatile oil, which is often carried by the air to a great distance: in hot climates it is most powerful in the morning and evening. The odour of the humeria has been perceived at the distance of three miles from the coast of South America, a species of tetracera sends its perfume as far from the island of Cuba, and the aroma of the Spice Islands is wafted out to sea. The variety of perfumes is infinite, and shows the innumerable combinations of which a few simple substances are capable, and the extreme minuteness of the particles of matter.

In northern and mean latitudes winter is a time of complete rest to the vegetable world, and in tropical climates the vigour of vegetation is suspended during the dry, hot season, to be resumed at the return of the periodical rains. Almost all plants sleep during the night; some show it in their leaves, others in their blossom. The mimosa tribe not only close their leaves at night, but their foot-stalks droop; in a clover-field not a leaf opens till after sunrise. The common daisy is a familiar instance of a sleeping flower; it shuts up its blossom in the evening, and opens its white and crimson-tipped star, the "day's eye," to meet the early beams of the morning sun; and then also "winking marybuds begin to ope their golden eyes." The crocus, tulip, convolvulus, and many others close their blossoms at different hours towards evening, some to open them again, others never. The condrilla of the walls opens at eight in the morning and closes for ever at four in the afternoon. Some plants seem to be wide awake all night, and to give



out their perfume then only, or at nightfall. Many of the jessamines are most fragrant during the twilight: the *olea fragrans*, the *daphne adorata*, and the night-stock reserve their sweetness for the midnight hour, and the night-flowering *sirius* turns night into day. It begins to expand its magnificent sweet-scented blossom in the twilight, it is full blown at midnight, and closes, never to open again, with the dawn of day:—these are “the bats and owls of the vegetable kingdom.”

Many plants brought from warm to temperate climates have become habituated to their new situation, and flourish as if they were natives of the soil; such as have been accustomed to flower and rest at particular seasons change their habits by degrees, and adapt themselves to the seasons of the country that has adopted them. It is much more difficult to transfer Alpine plants to the plains. Whether from a change of atmospheric pressure or mean temperature, all attempts to cultivate them at a lower level generally fail: it is much easier to accustom a plant of the plains to a higher situation.

Plants are propagated by seeds, offsets, cuttings, and buds; hence they, but more especially trees, have myriads of seats of life, a congeries of vital systems acting in concert, but independently of each other, every one of which might become a new plant. In this respect the fir and pine tribe are inferior to deciduous trees which lose their leaves annually, because they are not easily propagated except by seeds. It has been remarked that all plants that are propagated by buds from a common parent stock have the same duration of life: this has been noticed particularly with regard to some species of apple-trees in England.

A certain series of transitions take place throughout the lives of plants, each part being transformed and passing into another; a law that was first observed by the illustrious poet Göthe. For example the embryo leaves pass into common leaves, these into bractæ, the bractæ into sepals, the sepals into petals, which are transformed into stamens and anthers, and these again pass into ovaries with their styles and stigmas, that are to become the fruit and ultimately the seed of a new plant.

Plants are naturally divided into three classes, differing materially in organization:—The cryptogamia, whose flowers



and seeds are either too minute to be easily visible, or are hidden in some part of the plant, as in fungi, mosses, ferns, and lichens, which are of the least perfect organization. Next to these are the endogenous plants, which in their growth increase from the interior, as grasses and palms. In these the fresh leaves spring from the centre, and the footstalks of the old leaves form the outside of the stem: plants of this class are also known as monocotyledons, because they have but one seed-lobe which forms one little leaf in their embryo state. The flowers and fruit of this class are generally referable to some law in which the number three prevails, as, for example, the petals and other parts are three in number. The exogenous plants form the third class, which is the most perfect in its organization and by much the most numerous, including the trees of the forest and most of the flowering shrubs and herbs. They increase by coatings from without, as trees, where the growth of each year forms a concentric circle of wood round the pith or centre of the stem; these are also known as dicotyledonous plants, because their seeds have two lobes, which in their embryo state appear first in two little leaves above ground, like most of the European species. The parts of the flowers and fruit of this class generally have some relation to the number five.

The three botanical classes are distributed in very different proportions in different zones: endogenous plants, such as grasses and palms, are much more rare than the exogenous class. Between the tropics there are four of the latter to one of the grass or palm tribes, in the temperate zones six to one, and in the polar regions only two to one, because mosses and lichens are most abundant in the high latitudes, where exogenous plants are comparatively rare. In the temperate zones one-sixth of the plants are annuals, omitting the cryptogamia; in the torrid zone scarcely one plant in twenty is annual, and in the polar regions only one in thirty. The number of ligneous vegetables increases on approaching the equator, yet in North America there are 120 different species of forest-trees, whereas in the same latitudes in Europe there are only 34. The social plants, grasses, heaths, furze, broom, daisies, &c., which cover large tracts, are rare between the



tropics, except on the mountains and table-lands and on the llanos of equatorial America.

Equinoctial America has a more extensive and richer vegetation than any other part of the world; Europe has not above half the number of indigenous species of plants; Asia, with its islands, has somewhat less than Europe; Australia, with its islands in the Pacific, still less; and there are fewer vegetable productions in Africa than in any part of the globe of the same extent.

Since the constitution of the atmosphere is very much the same everywhere, vegetation depends principally on the sun's light, moisture, and the mean annual temperature, and it is also in some degree regulated by the heat of summer in the temperate zones. Between the tropics, wherever rain does not fall, the soil is burnt up and is as unfruitful as that exposed to the utmost rigour of frost; but where moisture is combined with heat and light, the luxuriance of the vegetation is beyond description. The abundance and violence of the periodical rains combine with the intense light and heat to render the tropical forests and jungles almost impervious from the rankness of the vegetation. This exuberance gradually decreases with the distance from the equator; it also diminishes progressively as the height above the level of the sea increases, so that each height has a corresponding parallel latitude where the climates and floras are similar, till the perpetual snow on the mountain-tops and its counterpart in the polar regions have a vegetation that scarcely rises above the surface of the ground. Hence in ascending the Himalaya or Andes from the luxuriant plains of the Ganges or Amazons, changes take place in the vegetation analogous to what a traveller would meet with in a journey from the equator to the poles. This law of decrease, though perfectly regular over a wide extent, is perpetually interfered with by local climate and soil. From the combination of various causes, as the distribution of land and water, their different powers of absorption and radiation, together with the form, texture, and clothing of the land, and the prevailing winds, it is found that the isothermal lines, or imaginary lines drawn through places on the surface of the globe which have the same mean annual temperature, do not correspond with the parallels of latitude. Thus in North America the climate is much colder than in the corresponding European latitudes.



Quebec is in the latitude of Paris, and the country is covered with deep snow four or five months in the year, and it has occurred that a summer has passed there in which not more than sixty days have been free from frost.

In the southern hemisphere, beyond the 34th parallel, the summers are colder and the winters milder than in corresponding latitudes of the northern hemisphere. Neither does the temperature of mountains vary exactly with their height above the sea; other causes, as prevailing winds, difference of radiation, and geological structure, concur in producing irregularities which have a powerful effect on the vegetable world.

However, no similarity of existing circumstances can account for whole families of plants being confined to one particular country, or even to a very limited district, which, as far as we can judge, might have grown equally well on many others. Latitude, elevation, soil, and climate, are but secondary causes in the distribution of the vegetable kingdom, and are totally inadequate to explain why there are numerous distinct botanical districts in the continents and islands, each of which has its own vegetation, whose limits are most decided when they are separated by the ocean, mountain-chains, sandy deserts, salt-plains, or internal seas. Each of these districts is the focus of families and genera, some of which are found nowhere else, and some are common to others, but, with a very few remarkable exceptions, the species of plants in each are entirely different or representative. This does not depend upon the difference in latitude, for the vegetation of the United States of North America is totally unlike that of Europe under the same isothermal lines, and even between the tropics the greatest dissimilarity often prevails under different degrees of longitude: consequently the cause of this partial distribution of plants, and that of animals also, which is according to the same law, must be looked for in those early geological periods when the earth first began to be tenanted by the present races of organised beings.

As the land rose at different periods above the ocean, each part, as it emerged from the waves, had probably been clothed with vegetation, and peopled with animals, suited to its position with regard to the equator, and to the climate and condition of the globe then being. And as the conditions and climate were different at each succeeding geological epoch, so each portion of the land, as it rose, would be characterized



by its own vegetation and animals, and thus at last there would be many centres of creation, as at this day, all differing more or less from one another, and hence alpine floras must be of older date than those in the plains. The vegetation and faunas of those lands that differed most in age and place would be most dissimilar, while the plants and animals of such as were not far removed from one another in time and place would have correlative forms or family likenesses, yet each would form a distinct province. Thus, in opposite hemispheres, and everywhere at great distances, but under like circumstances, the species are representatives of one another, rarely identical; when however, the conditions which suit certain species are continuous, identical species are found throughout, either by original creation or by migration. The older forms may have been modified to a certain extent by the succeeding conditions of the globe, but they never could have been changed, since immutability of species is a primordial law of nature. Neither external circumstances, time, nor human art, can change one species into another, though each to a certain extent is capable of accommodating itself to a change of external circumstances, so as to produce varieties even transmissible to their offspring.

The flora of Cashmere and the higher parts of the Himalaya mountains is similar to that of southern Europe, yet the species are representative, not identical. In the plains of Tartary, where from their elevation the degree of cold is not less than in the wastes of Siberia, the vegetation of one might be mistaken for that of the other; the gooseberry, currant, willow, rhubarb, and in some places the oak, hazel, cypress, poplar, and birch, grow in both, but they are of different species. The flora near the snow-line on the lofty mountains of Europe, and lower down, has also a perfect family likeness to that in high northern latitudes. In like manner many plants on the higher parts of the Chilian Andes are similar, and even identical, with those in Terra del Fuego; nay, the Arctic flora has a certain resemblance to that of the Antarctic regions, and even occasional identity of species. These remarkable coincidences may be accounted for by the different places having been at an early geological period at the same level above the ocean, and that they continue to retain part of their original flora after their relative positions have been changed. The tops of the Chilian Andes were



probably on a level with Terra del Fuego, when both were covered with the same vegetation, and in the same manner the lofty plains of Tartary may have acquired their vegetation when they were on the level of southern Siberia.

In the many vicissitudes the surface of the globe has undergone, continents formed at one period were broken up at another into islands and detached masses by inroads of the sea and other causes. Now Professor E. Forbes has shown that some of the primary floras and faunas have spread widely from their original centres over large portions of the continents before the land was broken up into the form it now has, and thus accounts for the similarity and sometimes identity of the plants and animals of regions now separated by seas,—as, for example, islands, which generally partake of the vegetation and fauna of the continents adjacent to them. Taking for granted the original creation of specific centres of plants and animals, Professor E. Forbes has clearly proved that “the specific identity, to any extent, of the flora and fauna of one area, with those of another, depends on both areas forming, or having formed, part of the same specific centre, or on their having derived their animal and vegetable population by transmission, through migration, over continuous or closely contiguous land, aided, in the case of Alpine floras, by transportation on floating masses of ice.”

By the preceding laws the limited provinces and dispersion of animal and vegetable life are explained, but the existence of single species in regions very far apart has not yet been accounted for.

Very few of the exogenous or dicotyledonous plants are common to two or more countries far apart: among the few, the *samolus valerandi*, a common English plant, is a native of Australia; the *potentilla tridendata*, not found in Europe, except on one hill in Augusshire, is common on the mountains of North America; and in the Falkland Islands there are more than 30 flowering plants identical with those in Great Britain.

There are many more instances of wide diffusion among the endogenous plants, especially grasses: the *phleum alpinum* of Switzerland grows without the smallest variation at the Straits of Magellan, and Mr. Bunbury met with the European quaking grasses in the interior of the country at the Cape of Good Hope; but the cellular or cryptogamous



class is most widely diffused—plants not susceptible of cultivation, of little use to man, and of all others the most difficult to transport. The *sticta aurata*, a Cornish lichen, is a native of the Cape of Good Hope, St. Helena, the West Indian islands, and Brazil; the *trichomanes brevisetum* grows scarcely anywhere but in Yorkshire and Madeira: and our eminent botanist, Mr. Brown, found 38 British lichens, and 28 British mosses in New Holland, yet in no two parts of the world is the vegetation more dissimilar.

Some plants are concentrated in particular spots: the *cinchona*, which furnishes the Peruvian bark, grows only on the Andes of Loxa and Venezuela; the cedar of Lebanon is indigenous on that celebrated mountain only; and the *disa grandiflora* is limited to a very small spot on the top of the table-mountain at the Cape of Good Hope; but whether these are remnants whose kindred have perished by a change of physical circumstances, or centres only beginning to spread, it is impossible to say.

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## CHAPTER XXII.

### VEGETATION OF THE GREAT CONTINENT—OF THE ARCTIC ISLANDS—AND OF THE ARCTIC AND NORTH TEMPERATE REGIONS OF EUROPE AND ASIA.

THE southern limit of the polar flora, on the great continent, lies mostly within the Arctic circle, but stretches along the tops of the Scandinavian mountains, and reappears in the high lands of Scotland, Cumberland, and Ireland, on the summits of the Pyrenees, Alps, and other mountains in southern Europe, as well as on the table-land of eastern Asia, and on the high ridges of the Himalaya.

The great European plain to the Ural Mountains, as well as the low-lands of England and Ireland, were at one period covered by a small sea full of floating ice and icebergs, which made the climate much colder than it now is. At the beginning of that period the Scandinavian range, the other continental mountains, and those in Britain and Ireland, were islands of no great elevation, and were then clothed with the



Arctic flora, or a representative of it, which they still retain now that they form the tops of the mountain-chains, and at that time both plants and animals were conveyed from one country to another by the floating ice. It is even probable, from the relations of the fauna and flora, that Greenland, Iceland, and the very high European latitudes, are the residue of a great northern land which had sunk down at the close of the glacial period, for there were many vicissitudes of level during that epoch. At all events it may be presumed that the elevation of the Arctic regions of both continents, if not contemporaneous, was probably not far removed in time. Similarity of circumstances had extended throughout the whole Arctic regions, since there is a remarkable similarity and occasional identity of species of plants and animals in the high latitudes of both continents, which is continued along the tops of their mountain-chains, even in the temperate zones; and there is reason to believe that the relations between the faunas and floras of Boreal America, Asia, and Europe, must have been established towards the close of the glacial period.

The flora of Iceland approaches nearer to the British than to that of any other country, yet only one in four of the Icelandic plants are known in our islands. There are 870 species in Iceland, of which more than half are flower-bearing: this is a greater proportion than is found in Scotland, but there are only 32 of woody texture. This flora is scattered in groups according as the plants like a dry, marshy, volcanic, or marine soil. Many grow to an unnatural size close to the hot-springs; thyme grows in cracks of the basin of the Great Geyser, where every other plant is petrified; and a species of chara flourishes and bears seed in a spring hot enough to boil an egg. The Icelanders make bread from metur, a species of wild corn, and also from the bulbous root of *polygnum viviparum*; their greatest delicacy is the *angelica archangelica*; Iceland moss, used in medicine, is an article of commerce. There are 583 species in the Feroe Islands, of which 270 are flowering plants: many thrive there that cannot bear the cold of Iceland.\*

\* Trevelyan's Travels in Iceland and the Feroe Islands.



## ARCTIC FLORA OF THE GREAT CONTINENT.

In the most northern parts of the Arctic lands the year is divided into one long intensely cold night and one bright and fervid day, which quickly brings to maturity the scanty vegetation. Within the limit of perpetual congelation the palmetto *invalis*, a very minute red or orange-coloured plant, finds nourishment on the surface of the snow, the first dawn of vegetable life: it is also found colouring large patches of snow on the Alps and Pyrenees.

Lichens are the first vegetables that appear at the limits of the snow-line, whether in high latitudes or mountain-tops, and they are the first vegetation that takes possession of volcanic lavas and new islands, where they prepare soil for plants of a higher order: they grow on rocks, stones, and trees, in fact on any thing that affords them moisture. More than 2400 species are already known: no plants are more widely diffused, and none afford a more striking instance of the arbitrary location of species, as they are of so little direct use to man that they could not have been disseminated by his agency. The same kinds prevail throughout the Arctic regions, and the species common to both hemispheres are very numerous. Some lichens produce brilliant red, orange, and brown dyes; and the *tripe de roche*, a species of *gyrophora*, is a miserable substitute for food, as our intrepid countryman Sir John Franklin and his brave companions experienced in their perilous Arctic journey.

Mosses follow lichens on newly-formed soil, and they are found everywhere throughout the world in damp situations, but in greatest abundance in temperate climates: 800 species are known, of which a great part inhabit the Arctic regions, constituting a large portion of the vegetation.

In Asiatic Siberia north of the 60th parallel of latitude the ground is perpetually frozen at a very small depth below the surface: a temperature of  $70^{\circ}$  below zero of Fahrenheit is not uncommon, and in some instances the cold has been  $120^{\circ}$  below zero. Then it is fatal to animal life, especially if accompanied by wind. In some places trees grow and corn ripens even at  $70^{\circ}$  of north latitude; but in the most northern parts boundless swamps, varied by lakes both of salt and fresh water, cover wide portions of this desolate country,



which is buried under snow nine or ten months in the year. As soon as the snow is melted by the returning sun, these extensive morasses are covered with coarse grass and rushes, while mosses and lichens mixed with dwarf willows clothe the plains; saline plants abound, and whole districts produce *diotis ceratoides*.

In Nova Zembla and other places in the far north the vegetation is so stunted that it barely covers the ground, but a much greater variety of minute plants of great beauty are crowded together there in a small space than in the Alpine regions of Europe where the same genera grow. This arises from the weakness of the vegetation; for in the Swiss Alps the same plant frequently occupies a large space excluding every other, as the dark-blue gentian, the violet-coloured pansy, the pink and yellow stone-crops. In the remote north, on the contrary, where vitality is comparatively feeble and the seeds do not ripen, thirty different species may be seen crowded together in a brilliant mass, no one having strength to overcome the rest. In such frozen climates plants may be said to live between the air and the earth, for they scarcely rise above the soil, and their roots creep along the surface, not having power to enter it. All the woody plants, as the *betula lanata*, the articulated willow, *andromeda tetragona*, with a few berry-bearing shrubs, trail along the ground, never rising more than an inch or two above it. The *salix lanata*, the giant of these boreal forests, never grows more than five inches above the surface, while its stem, ten or twelve feet long, lies hidden among the moss, owing shelter to its lowly neighbour.

The chief characteristic of the vegetation of the Arctic regions is the predominance of perennial and cryptogamous plants, and also of the sameness of its nature, but more to the south, where night begins to alternate with day, a difference of species appears in longitude as well as in latitude. A beautiful flora of vivid colours adorns these latitudes both in Europe and Asia during their brief but bright and ardent summer, consisting of potentillas, gentians, chickweeds, saxifrages, sedums, ranunculi, spiræas, drabas, artemisias, claytonias, and many more. Such is the power of the sun and the consequent rapidity of vegetation, that these plants spring up, blossom, ripen their seed, and die, in six weeks: in a lower latitude woody plants follow these, as berry-bearing



shrubs, the glaucous kalmia, the trailing azalia, and rhododendrons. The Siberian flora differs from that in the same European latitudes by the North American genera phlox, mitella, claytonia, and the predominance of asters, solidago, spiræa, milk-vetches, worm-wood and the saline plants, goosefoot, and saltworts.

Social plants abound in many parts of the northern countries, as grass, heath, furze, and broom: the steppes are an example of this on a very extensive scale. Both in Europe and Asia they are subject to a rigorous winter, with deep snow and chilling blasts of wind; and as the soil generally consists of a coating of vegetable mould over clay, no plants with deep roots thrive upon them; hence the steppes are destitute of trees, and even bushes are rare except in ravines: the grass is thin, but nourishing. Hyacinths and some other bulbs, mignonette, asparagus, liquorice, and wormwood, grow in the European steppes; the two last are peculiarly characteristic. The *nymphæa nilumba* grows in one spot five miles from the town of Astracan, and nowhere else in the wide domains of Russia: the leaves of this beautiful aquatic plant are often two feet broad, and its rose-coloured blossoms are very fragrant. It is also native in India and Tibet, where it is held sacred, as it was formerly in Egypt, where it is said to be extinct: it is one of the many instances of a plant growing in countries far apart.

Each steppe in Siberia has its own peculiar plants: the peplis and camphorasina are peculiar to the steppe of the Irtysh, and the *amaryllis tartarica* abounds in the meadows of eastern Siberia, where the vegetation bears a great analogy to that of north-western America: several genera and species are common to both.

Half the plants found by Wormskiold in Kamtschatka are European, with the exception of eight or ten, which are American. Few European trees grow in Asiatic Siberia, notwithstanding the similarity of climate, and most of them disappear towards the rivers Tobol and Irtysh.

In Lapland and in the high latitudes of Russia large tracts are covered with birch-trees, but the pine and fir tribe are the principal inhabitants of the north. Prodigious forests of these are spread over the mountains of Norway and Sweden, and in European Russia 200,000,000 acres are clothed with these coniferæ alone, or occasionally mixed with willows,



poplars, and alders. Although soils of pure sand and lime are absolutely barren, yet they generally contain enough of alkali to supply the wants of the fir and pine tribes, which require ten times less than oaks and other deciduous trees.

The Siberian steppes are bounded on the south by great forests of pine, birch, and willow: poplars, elms, and Tartarian maple overhang the upper courses of the noble rivers which flow from the mountains to the Frozen Ocean, and on the banks of the Yenessei the *pinus cembra*, or Siberian pine, with edible fruit, grows 120 feet high. The Altaï are covered nearly to their summit with similar forests, but on their greatest heights the stunted larch crawls on the ground, and the flora is like that of northern Siberia: round the lake Baikal the *pinus cembra* grows nearly to the snow-line.

Forests of black birch are peculiar to Da-Ouria, where there are also apricot and apple trees, and rhododendrons, of which a species grows in thickets on the hills, with yellow blossoms. Here and everywhere else throughout this country are found all the species of caragana, a genus entirely Siberian. Each terrace of the mountains and each steppe on the plains has its peculiar plants, as well as some common to all: perennial plants are more numerous than annuals.

If temperature and climate depended upon latitude alone, all Asia between the 50th and 30th parallels would have a mild climate; but that is far from being the case, on account of the structure of the continent, which consists of the highest table-lands and the lowest plains on the globe.

The table-land of Tibet, where it is not cultivated, has the character of great sterility, and the climate is as unpropitious as the soil: frost, snow, and sleet begin early in September, and continue with little interruption till May; snow, indeed, falls every month in the year. The air is always dry, because in winter moisture falls in the form of snow, and in summer it is quickly evaporated by the intense heat of the sun. The thermometer sometimes rises to 144° of Fahrenheit in the sun, and even in winter his direct rays have great power for an hour or two, so that a variation of 100° in the temperature of the air has occurred in twelve hours. Notwithstanding these disadvantages there are sheltered spots which produce most of the European grain and fruit, though the natural vegetation bears the Siberian cha-



racter, but the species are quite distinct. The most common indigenous plants are Tartarian furze and various prickly shrubs resembling it, gooseberries, currants, hyssop, dog-rose, dwarf sow-thistle, equisetum, rhubarb, lucern, and assafœtida, on which the flocks feed. Prangos, an umbelliferous plant with broad leaves and scented blossom, is peculiar to Ladak and Tibet. Mr. Moorcroft says it is so nutritious, that sheep fed on it become fat in twenty days. There are three species of wheat, three of barley, and two of buckwheat, natives of the lofty table-land, where the sarsinh is the only fruit known to be indigenous. Owing to the rudeness of the climate trees are not numerous, yet on the lower declivities of some mountains there are aspens, birch, yew, ash, Tartaric oak, various pines, and the pavia, a species of horse-chestnut. Much of the table-land of Tartary is occupied by the Great Gobi and other deserts of sand, with grassy steppes near the mountains; but of the flora of these regions we know nothing.

## FLORA OF BRITAIN AND OF MIDDLE AND SOUTHERN EUROPE.

The British Islands afford an excellent illustration of distinct provinces of animals and plants, and also of their migration from other centres. Professor E. Forbes has determined five botanical districts, four of which are restricted to limited provinces, whilst the fifth, which comprehends the great mass of British plants, is everywhere, either alone or mixed with the others. The first includes the flora of the mountain districts in the west and south-west of Ireland, which is similar to that in the north of Spain. The flora in the south of England and south-east of Ireland is different from that in all other parts of the British Islands, but is intimately related to that of the Channel Islands and the French coast opposite to them.

In the south-east of England the flora is like that on the adjacent coast of France. The tops of the Scottish mountains are the focus of a separate flora, a few of whose plants are found also on the summits of the mountains in Cumberland and Wales, and Scandinavian plants are mingled with it in Scotland. The fifth, of more recent origin than the



Alpine flora, includes all the ordinary flowering plants, as the common daisy and primrose, hairy ladies' smock, upright meadow crowfoot, and the lesser celandine, together with our common trees and shrubs, has migrated from Germany before England was separated from the continent of Europe by the British Channel. It can be distinctly traced in its progress across the island, but the migration was not completed till after Ireland was separated from England by the Irish Channel, and that is the reason why many of the ordinary English plants, animals, and reptiles are not found in the sister island, for the migration of animals was simultaneous with that of plants, and took place between the last of the tertiary periods and the historical epoch, that of man's creation: it was extended also over a great part of the Continent.

Deciduous trees are the chief characteristic of the temperate zone of the old continent, more especially of middle Europe: these thrive best in soil produced by the decay of the primary and ancient volcanic rocks, which furnish abundance of alkali. Oaks, elms, beech, ash, larch, maple, lime, alder, and sycamore, all of which lose their leaves in winter, are the prevailing vegetation, occasionally mixed with fir and pine.

The undergrowth consists of wild apple, cherry, yew, holly, hawthorn, broom, furze, wild rose, honeysuckle, clematis, &c. The most numerous and characteristic herbaceous plants are the umbelliferous class, as carrot and anise, the campanulas, the chicoraceæ, a family to which lettuce, endive, dandelion, and sow-thistle belong. The cruciform tribe, as wallflower, stock, turnip, cabbage, cress, &c., are so numerous, that they form a distinguishing feature in the botany of middle Europe, to which 45 species of them belong. This family is almost confined to the northern hemisphere, for of 800 known species, only 100 belong to the southern, the soil of which must contain less sulphur, which is indispensable for these plants.

In the Pyrenees, Alps, and other high lands in Europe, the gradation of botanical forms from the summit to the foot of the mountains is similar to that which takes place from the Arctic to the middle latitudes of Europe. The analogy, however, is true only when viewed generally, for many local circumstances of climate and vegetation interpose, and al-



though the similarity of botanical forms is very great between certain zones of altitude and parallels of latitude, the species are for the most part different.

Evergreen trees and shrubs become more frequent in the southern countries of Europe, where about a fourth part of the ligneous vegetation never entirely lose their leaves. The flora consists chiefly of ilex, oak, cypress, hornbeam, sweet chestnut, laurel, laurastina, the apple tribe, manna, and the flowering ash, carob, jujub, juniper, terebinthinas, and lentiscus pistaccio, which yield resin and mastick, arbutus, myrtle, jessamine, yellow and white, various pines, as the pinus maritima, and pinus pinea, or stone pine, which forms so picturesque a feature in the landscape of southern Europe. The most prevalent herbaceous plants are caryophyllæ, as pinks, stellaria and arenarias, and also the labiate tribe, mint, thyme, rosemary, lavender, with many others, all remarkable for their aromatic properties, and their love of dry situations. Many of the choicest plants and flowers, which adorn the gardens and grounds in northern Europe, are indigenous in these warmer countries; the anemone, tulip, mignonette, narcissus, gladiolus, iris, asphodel, amaryllis, carnation, &c. In Spain, Portugal, Sicily, and the other European shores of the Mediterranean, tropical families begin to appear in the arums, plants yielding balsams, oleander, date and palmetto palms, and grasses of the order panicum or millet, cyperaceæ, or sedges, aloe and cactus. In this zone of transition there are six herbaceous for one woody plant.

### FLORA OF TEMPERATE ASIA.

The vegetation of western Asia approaches nearly to that of India at one extremity, and Europe at the other; of 281 genera of plants which grow in Asia Minor and Persia, 109 are European. Syria and Asia Minor form a region of transition, like the other countries on the Mediterranean, where the plants of the temperate and tropical zones are united. We owe many of our best fruits and sweetest flowers to these regions. The cherry, almond, oleander, syringa, locust tree, &c., come from Asia Minor; the walnut, peach, melon, cucumber, hyacinth, ranunculus, come from Persia; the date, palm, fig, olive, mulberry, and damask rose, come from



Syria; the vine and apricot are Armenian, the latter grows also everywhere in middle and northern Asia. The tropical forms met with in more sheltered places are the sugar-cane, date and palmetto palms, mimosas, acacias, asclepea gigantea, and other arborescent apocineæ. On the mountains south of the Black Sea, American types appear in rhododendrons, and the *azelea pontica*, and herbaceous plants are numerous and brilliant in these countries.

The table-land of Persia, though not so high as that of eastern Asia, resembles it in the quality of the soil, which is chiefly clayey, sandy, or saline, and the climate is very dry; hence vegetation is poor, and consists of thorny bushes, acacias, mimosas, tamarisk, jujub, and assafoetida. Forests of oak cover the Lusistan mountains, but the date palm is the only produce of the parched shores of the Arabian Gulf and of the oases on the Persian table-land. In the valleys, which are beautiful, there are clumps of Oriental plane and other trees, hawthorn, tree roses, and many of the odoriferous shrubs of Arabia Felix.

Afghanistan produces the seedless pomegranate. The true indigo grows in the lower offsets of the Hindoo-Coosh, where the valleys are covered with clover, thyme, violets, and many odoriferous plants: the greater part of the trees in the mountains are of European genera, though all the species of plants, both woody and herbaceous, are peculiar.

Hot arid deserts bound India on the west, where the stunted and scorched vegetation consists of tamarisk, thorny acacia, deformed euphorbiæ, and almost leafless thorny trees, shaggy with long hair, by which they imbibe moisture and carbon from the atmosphere. Indian forms appear near Delhi, in the genera *flacourtia* and others, mixed with Syrian plants. East of this transition the vegetation becomes entirely Indian, except on the higher parts of the mountains, where European types prevail.

The Himalaya Mountains form a distinct botanical district. Immediately below the snow-line the flora is almost the same with that on the high plains of Tartary, to which may be added rhododendrons and andromedas, and among the herbaceous plants a primrose appears. Lower down vast tracts are covered with prostrate bamboos, and European forms become universal, though the species are Indian, as gentians, plantagos, campanulus, and gale. There are extensive forests



of coniferæ, consisting chiefly of *pinus excelsa*, *deodora*, and *morinda*, with many deciduous forest and fruit-trees of European genera. A transition from this flora to a tropical vegetation takes place between the altitudes of 9000 and 5000 feet, because the rains of the monsoons begin to be felt in this region, which unites the plants of both. Here the scarlet and other rhododendrons grow luxuriantly; walnuts, and at least ten species of oak, attain a great size, one of which, the *quercus semicarpifolia*, has a clean trunk from 80 to 100 feet high. Geraniums, labiate plants, are mixed in sheltered spots with the tropical genera of *scitamineæ*, or the ginger tribe; bignonias and balsams, and camelias, grow on the lower part of this region.

It is remarkable that Indian, European, American and Chinese forms are united in this zone of transition, though the distinctness of species still obtains: the *triosteum*, a genus of the honeysuckle tribe, is American; the *abelia*, another genus of the same, together with the *camelia* and *tricyrtis*, are peculiarly Chinese; the daisy and wild thyme are European. A few of the trees and plants mentioned descend below the altitude of 5000 feet, but they soon disappear on the hot declivities of the mountain, where the *erythrina*, *monosperma*, and *bombex heptaphyllum*, are the most common trees, together with the *millingtonææ*, a tribe of large timber trees, met with everywhere between the Himalaya and 10° north latitude. The *shorea robusta*, *dalbergia*, and *cedrela*, a genus allied to mahogany, are the most common trees in the forests of the lower regions of these mountains.

The temperate regions of eastern Asia, including Chinese Tartary, China, and Japan, have a vegetation totally different from that of any other part of the globe similarly situated, and shows in a strong point of view the distinct character which vegetation assumes in different longitudes. In Mandshuria and the vast mountain-chains that slope from the eastern extremity of the high Tartarian table-land to the fertile plains in China, the forests and flora are generally of European genera, but Asiatic species; in these countries the buckthorn and honeysuckle tribes are so numerous as to give a peculiar character to the vegetation.

The transition zone in this country lies between the 35th and 27th parallels of north latitude, in which the tropical flora is mixed with that of the northern provinces. The



prevailing plants on the Chinese low grounds are glycyne, hortensia, the camphor laurel, stillingia sebifera, or wax tree, clerodendron, hibiscus, sinensis, thuia orientalis, olea fragrans, the sweet blossoms of which are mixed with the finer teas to give them flavour; melia azedarach, or Indian pride, the paper mulberry, and others of the genus, and camelia sasanqua, which covers hills in the province of Kiong-si. The tea-plant, and other species of camelia, grow in many parts; the finest tea is the produce of a low range of hills between the 30th and 32d parallels, an offset from the great chain of Peling. The tea-plant is not confined to China, it grows on the mountains of Assam, and as some species of the camelia tribe are indigenous in the temperate regions of the Himalaya, it might probably be cultivated in that range.

The climate of Japan is milder than its latitude would indicate, owing to the influence of the surrounding ocean. European forms prevail in the high lands, as they do generally throughout the mountains of Asia and the Indian Archipelago, with the difference of species, as abies cembra, strobilus, and larix. The Japanese flora is similar to the Chinese, and there are 30 American plants, besides others of Indian and tropical climates. These islands, nevertheless, have their own peculiar flora, distinct in its nature; as the saphora, corchorus, aukuba, mespilus, and pyrus Japonica, rhus vernix, oralis cordata, the anise tree, daphne odorata, the soap tree, various species of the calecanthus tribe, the custard apple, the khair mimosa, which yields the catechu, the leechiee, the sweet orange, the cycas revoluta, a plant resembling a dwarf palm, with various other fruit. Many tropical plants mingle with the vegetation of the cocoa-nut and fan-palms.

Thus the vegetation in Japan and China is widely different from that in the countries bordering the Mediterranean, though between the same parallels of latitude. In the tropical regions of Asia, where heat and moisture are excessive, the influence of latitude vanishes altogether, and the peculiarities of the vegetation in different longitudes become more evident.



## CHAPTER XXIII.

FLORA OF TROPICAL ASIA—OF THE INDIAN ARCHIPELAGO,  
INDIA, AND ARABIA.

TROPICAL Asia is divided by nature into three distinct botanical regions: the Malayan peninsula with the Indian Archipelago; India, south of the Himalaya, with the island of Ceylon; and the Arabian peninsula. The two first have strong points of resemblance, though their floras are peculiar.

FLORA OF THE INDO-CHINESE PENINSULA AND  
THE INDIAN ARCHIPELAGO.

Many of the vegetable productions of the peninsula beyond the Ganges are the same with those of India, mixed with the plants of the Indian Archipelago, so that this country is a region of transition, though it has a splendid vegetation of innumerable native productions, dyes of the most vivid hues, spices, medicinal plants, and many with the sweetest perfume. The soil in many places yields three crops in the year; the fruit of India, and most of those of China, come to perfection in the low lands. The areng palm is peculiarly characteristic of the Malayan peninsula; it yields sago and wine, is an ugly plant, covered with black fibres like coarse horse-hair, so strong that cordage is made of it. Teak is plentiful; almost all that is used in Bengal comes from the Birman empire, though it is less durable than that of the Malabar coast. The *hopœa odorata* is so large that a canoe is made of a single trunk; the *cardonia integrifolia* is held in such veneration that every Birman house has a beam of it.

There are seven species of native oak in the forests; the *mimosa catechu*, which furnishes the *terra japonica* used in medicine; the trees which produce varnish and stick-lac; the *glyphyrea nitida*, a myrtle, the leaves of which are used as tea in Bencoolen, called by the natives the tree of long



life. The coasts are wooded by the *heriliera robusta*, a large tree which thrives within reach of the tide ; bamboos with stems a foot and a half in diameter grow in dense thickets in the low lands. The palmyra palm and the *borassus flabelliformis* grow in extensive groves in the valley of the Irawaddie : it is a magnificent tree, often 100 feet high, remarkable for its gigantic leaves, one of which would shelter twelve men.

The anomalous trees, the *zamas* and *cycades*, somewhat like a palm with large pinnated leaves, but of a different genus, are found here and in tropical India ; those in America are of a different species. *Orchideæ* and tree-ferns are innumerable in the woody districts of the peninsula.

The vegetation of the Indian Archipelago is gorgeous beyond description ; although in many instances it bears a strong analogy to that of the Malayan peninsula, tropical India, and Ceylon, still it is in an eminent degree peculiar. The height of the mountains causes variety in the temperature sufficient to admit of the growth of dammer pines, oaks, *rhododendrons*, *magnolias*, *valerians*, *honey-suckles*, *bilberries*, *gentians*, *oleasters*, and other European orders of woody and herbaceous plants ; yet there is not one species in common.

Jungle and dense pestilential woods entirely cover the smaller islands and the plains of the larger ; the coasts are lined with thickets of mangroves, a matted vegetation of forest trees, palms, bamboos, and coarse grass, entwined with climbing and creeping plants, and overgrown by orchideous parasites in myriads. The forest trees of the Indian Archipelago are almost unknown ; teak and many of the continental trees grow there, but the greater number are peculiarly their own. The naturalist Rumphius had a cabinet inlaid with 400 kinds of wood, the produce of Amboyna and the Molucca Islands.

Sumatra, Java, and the adjacent islands, are the region of the *caryota urens* and of the *dryobalanops camphora* of the laurel tribe, in the stems of which solid lumps of camphor are found. All the trees of that order, and of several others, are peculiar to these islands, and 78 species of trees and shrubs of the *melastoma* tribe grow there and in continental India. There are thickets of the sword-leaved *vaquois* tree and of the *pandanus* or screw-pine, a plant resembling the



anana, with a blossom like that of a bulrush, very odoriferous, and in some species edible.

This is the region of spices, which are very limited in their distribution : the *myristica moschata*, the nutmeg, and mace-plant, is confined to the Banda Islands, but it is said to have been discovered lately in New Guinea. The Amboyna group is the focus of the *caryophyllus aromaticus*, a myrtle, the buds of which are known as cloves. Various species of cinnamon and cassia, both of the laurel tribe, together with varieties of pepper, different from those in India and Ceylon, grow in this archipelago. Some of the most excellent fruits are indigenous here only, as the dourio, the ayer ayer, langsats, the choapa of Molucca, peculiar kinds of orange, lemon, and citron, with others known only by name elsewhere. Those common to the continent of India are the jam-rose, rose-apple, jack, various species of bread-fruit, mango, mangosteen, and the banana, which is luxuriant.

Here the nettle tribe assume the most pernicious character, as the upas tree of Java, one of the most deadly vegetable poisons, and even the plants resembling our common nettle, are so acrid that the sting of one in Java occasions not only pain but illness, which lasts for days. A nettle in the island of Timor, called by the natives the "Devil's leaf," is so poisonous that it produces long illness and even death. The *chelik*, a shrub growing in the dense forests, produces a poison even more deadly than the upas. Some of the fig genus, which belongs also to the natural order of nettles, have acrid juices. Trees of the cashew tribe have a milky sap : the fine japan lacquer is made from the juice of the *stagmaria verniciflua*. Palms are very splendid here, generally of peculiar species and limited in their distribution, as the *nissa* and *Barringtonia*. No country is richer in club-mosses and orchideous plants, which overrun the trees in thousands in the deep dark mountain-forests, choked by huge creeping plants, an undergrowth of gigantic grasses, through which not a ray of light penetrates.

Sir Stamford Raffles describes the vegetation of Java as "fearful." In these forests the air is heavy, charged with dank and deadly vapours, never agitated by a breath of wind ; the soil, of the deepest black vegetable mould, always moist and clammy, stimulated by the fervid heat of a tropical sun, produces trees whose stems are of a spongy texture



from their rapid growth, loaded with parasites, particularly the orchideous tribe, of which no less than 300 species are peculiar to that island. Tree-ferns are in the proportion of one to twenty of the other plants, and form a large portion of the vegetation of Java and all these islands; and there are above 200 tropical species of club-mosses growing to the height of three feet, whereas in cold countries they creep on the ground.

The *Rafflesia*, of which there are four genera, are the most singular productions of this archipelago. The most extraordinary is common to Java and Sumatra, where it was discovered by Mr. Arnold, and therefore is called *Rafflesia Arnoldi*. It is a parasitical plant, with buds the size of an ordinary cabbage, and the flower, which smells of carrion, is of a brick-red colour, three feet and a half in diameter: that found by Mr. Arnold weighed fifteen pounds, and the cup in its centre could contain twelve pints of liquid.

According to Sir Stamford Raffles there are six distinct climates in Java, from the top of the mountains to the sea, each having an extensive indigenous vegetation. No other country can show an equal abundance and variety of native fruit and esculent vegetables. There are 100 varieties of rice, and of fragrant flowers, shrubs, and ornamental trees the number is infinite. Abundant as the orchideæ are in Java, Ceylon, and the Burmese empire, these countries possess very few that are common to them all, so local is their distribution. Ferns are more plentiful in this archipelago than elsewhere: tree-ferns are found chiefly between or near the tropics, in airless damp places.

## INDIAN FLORA.

The plains of Hindostan are so completely sheltered from the Siberian blasts by the high table-lands of Tartary and the Himalaya Mountains, that the vegetation at the foot of that range already assumes a tropical character. In the jungles and lower ridges of the fertile valley of Nepal, and on the dark and airless recesses of the Silhet forests, arborescent ferns and orchideous plants are found in profusion, scarcely surpassed even in the islands of the Indian Archipelago—indeed the marshy Tariyane is full of them. The



lowest ranges of the Himalaya, the pestilential swamp of the Tariyane, the alluvial ridges of the hills that bound it on the south, and many parts of the plains of the Ganges, are covered with primeval forests, which produce whole orders of large timber trees, frequently over-run with parasitical loranthe.

The native fruit of India are many; the orange tribe is almost all of Indian origin, though some of the species are now widely spread over the warmer parts of the other continents and the more distant countries of Asia. Two or three species are peculiar to Madagascar; one is found in the forests of the Essequibo and another in Brazil, which are the only exceptions known. The *limonia laureola* grows on the tops of the high Asiatic mountains, which are covered with snow several months in the year; and the wampee, a fruit much esteemed in China and the Indian Archipelago, is produced by a species of this order. The vine grows wild in the forests; plantain, banana, jamrose, guava, mango, mangosteen, date, areca, palmyra, cocoa-nut, and gameto-palms are all Indian, also the gourd family. The Scitaminae, or ginger-tribe, are so numerous, that they form a distinguishing and beautiful feature of Indian botany: they produce ginger, cardamoms, and turmeric. The flowers peculiar to India are brilliant in colours, but generally without odour, except the rose and some jessamines.

The greater part of the trees and plants mentioned belong also to tropical India, where vegetation is still more luxuriant; a large portion of that magnificent country, containing 1,000,000 square miles, has been cultivated time immemorial, although vast tracts still remain in a state of nature. Those extensive mountain-chains which traverse and surround the Deccan are rich in primeval forests of stupendous growth with dense underwood. The most remarkable of these trees are the Indian cotton-tree and the dombeya, which is of the same order; that which produces the Trincomalee wood, used for building boats at Madras; the red-wood tree, peculiar to the Coromandel coast, the satin-wood, the superb *butea frondosa*, the agallshium tribe, which yields the odorous wood of aloes mentioned in Scripture, the *melaleuca leucadendron* and the *melaleuca cujapute*, from which the oil is prepared. The dragon-tree is a native of India, though not exclusively, as some of the best specimens grow in the Azores and Madagascar, where it is planted for



hedges. Sanders-wood and dragon's-blood are obtained from the *pterocarpus sandalinus* and *draco*; the sappan-tree gives a purple dye: these are all of the leguminous or bean tribe, of which there are 452 Indian species: ebony grows in these tropical regions, in Mauritius, and the south coast of Africa.

Some of the fig tribe are among the most remarkable vegetable productions of India for gigantic size and peculiarity of form, which renders them valuable in a hot climate from the shade which their broad-spreading tops afford. Some throw off shoots from their branches, which take root on reaching the ground, and after increasing in girth with wonderful rapidity, produce branches which also descend to form new roots, and this process is continued till a forest is formed round the parent tree. Mr. Reinwardt saw in the island of Simao a large wood of the *ficus Benjamina* which sprung from one stem. The *ficus Indicus*, or banyan tree, is another instance of this wide-spreading growth; it is found in the islands, but is in greatest perfection around the villages in the Circar mountains. The camphor genus is mostly Indian, as well as many more of the laurel tribe of great size. The banana is the most generally useful tree in this country; its fruit is food, its leaves are applied to many domestic purposes, and flax fit for making muslin is obtained from its stem.

Palms, the most stately and graceful of the vegetable productions of tropical regions, are abundant in India, in forests, in groups, and in single trees. Some species grow at the limit of perpetual snow, some 900 feet above the sea, others in valleys and on the shores of the continent and islands. They decrease in number and variety as the latitude increases, and terminate at Nice, in 44° N. lat., their limit in the great continent. The leaves of some are of gigantic size, and all are beautiful, varying in height from the slender *calamus rudentum*, 500 feet high, to the *chamærops humilis*, not more than 15 or 20. Different species yield wine, oil, wax, flour, sugar, thread, and rope; weapons and utensils are made of their stems and leaves; they serve for the construction of houses; the cocoa-nut palm gives food and drink; sago is made from all except the areca catechu, the fruit of which, the betel-nut, is used by the natives for its intoxicating quality. A few of the species are widely



spread, for example the cocoa-nut palm, though they are in general very limited in their distribution.

The island of Ceylon, which may be regarded as the southernmost extremity of the Indian peninsula, is very mountainous, and rivals the islands of the Indian Archipelago in luxuriance of vegetable productions, and in some respects bears a strong resemblance to them. The laurel, the bark of which is cinnamon, is indigenous, and one of the principal sources of the revenue of Ceylon. The taleput leaves of the areca palm are of such enormous size, that they are applied to many uses by the Cingalese: in ancient times stripes of the leaf were written upon with a sharp style, and served as books. The sandal-wood of Ceylon is of a different species from that of the South Sea Islands, and its perfume more esteemed. Indigo is indigenous, and so is the choya, whose roots give a scarlet dye. The mountains produce a great variety of beautiful woods used in cabinet-work. It is a remarkable circumstance in the distribution of plants, that the orchideæ are very numerous in this island, and that there should be none in the Indian peninsula.

### ARABIAN VEGETATION.

The third division of the tropical flora of Asia is the Arabian, which differs widely from the other two, and is chiefly marked by trees yielding balsams. Oceans of barren sand extend to the south, from Syria through the greater part of Arabia, varied only by occasional oases in those spots where a spring of water has reached the surface; there the prevalent vegetation consists of the grasses, holcus and panicum dicotomum growing under the shade of the date-palm; mimosas and stunted prickly bushes appear here and there in the sand. There is verdure on the mountains, and along some of the coasts, especially in the province of Yemen, which has a flora of its own, and is the native country of coffee, which is now cultivated over half the globe. Most of the coffee used is the progeny of a single plant brought from Mocha to the botanic garden at Amsterdam, by Van Hoorn, the governor of Batavia, in the year 1718. Plants were sent to Surinam, from whence they spread rapidly over the warm parts of America and the West



Indian Islands. The *keura odorifera*, a superb tree, with agreeable perfume, eight species of figs, the three species of *amyris gileadensis*, or balm of Gilead, *opobalsamum* also yielding balsam, and the *kataf*, from which myrrh is supposed to come, are peculiar to Arabia. Frankincense is said to be the produce of the *Boswellia serrata*; and there are many species of acacia, among others the *acacia arabica*, which produces gum arabic. The arak and tamarind trees connect the botany of Arabia with that of the West Indies, while it is connected with that of the Cape of Good Hope by *Stapelias*, *mesembryanthemums*, and liliaceous flowers. The character of Arabian vegetation, like that of other dry hot climates, consists in its odoriferous plants and flowers.

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## CHAPTER XXIV.

AFRICAN FLORA—FLORA OF AUSTRALIA, NEW ZEALAND, NORFOLK ISLAND, AND OF POLYNESIA.

THE northern coast of Africa, and the range of the Atlas generally, may be regarded as a zone of transition, where the plants of southern Europe are mingled with those peculiar to the country; half the plants of northern Africa are also found in the other countries on the shores of the Mediterranean. Of 60 trees and 248 shrubs which grow there, 100 only are peculiar to Africa, and about 18 of these belong to its tropical flora. There are about six times as many herbaceous plants as there are trees and shrubs; and in the Atlas Mountains, as in other chains, the perennial plants are much more numerous than annuals. Evergreens predominate, and are the same as those on the other shores of the Mediterranean. The pomegranate, the locust-tree, the oleander, and the palmetto abound; and the *cistus* tribe give a distinct character to the flora. The *sandarach*, or *thua articulata*, peculiar to the northern side of the Atlas Mountains and to Cyrenaica, yields close-grained hard timber, used for the ceiling of mosques, and is supposed to be the *shittim-wood* of Scripture. The Atlas produces seven or eight species of oak, various pines, especially the *pinus maritima*, and forests of the Aleppo pine in Algiers. The



sweet-scented arborescent heath and *erica scoparia* are native here, also in the Canary Islands and the Azores, where the tribe of house-leeks characterizes the botany. There are 534 phanerogamous plants, or such as have the parts of fructification evident, in the Canary Islands; the *pinus canariensis* is peculiar, and also the *dracænæ*, which grow in perfection here. The stem of the *dracæna draco*, of the Villa Oratavas in Teneriffe, measures 46 feet in circumference at the base of the tree, which is 75 feet high. It is known to have been an object of great antiquity in the year 1402, and is still alive, bearing blossoms and fruit. If it be not an instance of the partial location of plants, there must have been intercourse between India and the Canary Islands in very ancient times.

Plants with bluish-green succulent leaves are characteristic of tropical Africa and its islands; and though the group of the Canaries has plants in common with Spain, Portugal, Africa, and the Azores, yet there are many species, and even genera, which are found in them only; and the height of the mountains causes much variety in the vegetation.

On the continent, south of the Atlas, a great change of soil and climate takes place; the drought on the borders of the desert is so excessive that no trees can resist it, rain hardly ever falls, and the scorching blasts from the south speedily dry up any moisture that may exist; yet in consequence of what descends from the mountains, the date-palm forms large forests along their base, which supply the inhabitants with food, and give shelter to crops which could not otherwise grow. Stunted plants are the only produce of the desert, yet large tracts are covered with the *pennisetum dichotomum*, a harsh prickly grass, which, together with the *alhagi maurosin*, are the food of camels.

The plants peculiar to Egypt are acacias, mimosas, cassias, tamarisks, the lotus *nymphæa*, the blue lotus, the papyrus, from which probably the first substance used for writing upon was made, and has left its name to that we now use: also the *ziziphus* or jujub, various *mesembryanthemums*, and most of the plants of Barbary grow here. The date-palm is not found higher on the Nile than Thebes, where it gives place to the doom-palm, or *crucifera Thebaica*, peculiar to this district, and singular as being the only palm that has a branched stem.



The eastern side of equatorial Africa is less known than the western, but the floras of the two countries, under the same latitude, have little affinity; on the eastern side the rubiaceæ, the euphorbiæ, a race peculiarly African, and the malviaceæ, are most frequent. The genera *danais* of the *coffea* tribe distinguish the vegetation of Abyssinia, also the *dombeya*, the *senaceæ*, a species of vine, various *jessamines*, a beautiful species of honey-suckle; and Bruce says the caper-tree grows to the height of the elm, with white blossoms, and fruit as large as a peach. The *daroo*, or *ficus sycamoris*, and the *arak* tree, are native. The *kollquall*, or *euphorbia antiquorum*, grows 40 feet high on the plain of Baharnagach, in the form of an elegant branched candelabrum, covered with scented fruit. The *kantuffa*, or thorny shrub, is so great a nuisance from its spines, that even animals avoid it. The *erythrina Abyssinica* bears a poisonous red bean with a black spot, used by the Shangalla and other tribes for ages, as a weight for gold, and by the women as necklaces. Mr. Rochet has lately brought some seeds of new grain from Shoa, that are likely to be a valuable addition to European cerealia.

The vegetation of tropical Africa, on the west, is known only along the coast, where some affinity with that of India may be observed. It consists of 573 species of flower-bearing plants, and is distinguished by a remarkable uniformity, not only in orders and genera, but even in species, from the 16° of north latitude to the river Congo in 6° of south latitude. The most prevalent are the grasses and bean tribes, the *cyperaceæ*, *rubiceæ*, and the *compositæ*. The *Adamsonia*, or *boabab* of Senegal, is one of the most extraordinary vegetable productions; the stem is sometimes 34 feet in diameter, though the tree is rarely more than 50 or 60 feet high; it covers the sandy plains so entirely with its umbrella-shaped top, that a forest of these trees presents a compact surface, which at some distance seems to be a green field. Cape Verde has its name from the numbers that conceal the barren soil under their spreading tops: some of them are very old, and, with the dragon-tree at Teneriffe, are supposed to be the most ancient vegetable inhabitants of the earth. The *pandanus candelabrum*, instead of growing crowded together in masses like the *boabab*, stands solitary on the equatorial plains, with its lofty forked branches ending in tufts of long



stiff leaves. Numerous sedges, of which the papyrus is the most remarkable, give a character to this region, and cover boundless plains waving in the wind like corn-fields, while other places are overgrown by forests of gigantic grasses with branching stems.

A rich vegetation, consisting of impenetrable thickets of mangrove, the poisonous manchineel, and many large trees, cover the deltas of the rivers, and even grow so far into the water, that their trunks are coated with shell-fish, but the pestilential exhalations render it almost certain death to botanize in this luxuriance of nature.

Various trees of the soap and sapodilla tribes are peculiar to Africa; the butter-tree of the enterprising but unfortunate Mungo Park, the star apple, the cream fruit, the custard apple, and the water vine, are plentiful in Senegal and Sierra Leone. The safu and bread-fruit of Polynesia are represented here by the musanga, a large tree of the nettle tribe, the fruit of which has the flavour of the hazel-nut. A few palms have very local habitations, as the elais Guineensis, found on that coast. That graceful tribe is less varied in species in equatorial Africa than in the other continents.

The flora of south Africa differs entirely from that of the northern and tropical zones, and as widely from that of every other country, with the exception of Australia and some parts of Chili. The soil of the table-land at the Cape of Good Hope, stretching to an unknown distance, and of the Karoo plains and valleys between the mountains, is sometimes gravelly, but more frequently is composed of sand and clay; in summer it is dry and parched, and most of its rivers are dried up; it bears but a few stunted shrubs, some succulent plants and mimosas along the margin of the river courses. The sudden effect of rain on the parched ground is like magic; it is recalled to life, and in a short time is decked with a beautiful and peculiar vegetation, comprehending, more than any other country, numerous and distinctly defined foci of genera and species.

Twelve thousand species of plants have been collected in the colony of the Cape, in an extent of country about equal to Germany. Of these heaths and proteas are two very conspicuous tribes; there are 300 species of the former, and 200 of the latter, both of which have nearly the same limited



range, though Mr. Bunbury found two heaths, and the protea cynaroides, the most splendid of the family, bearing a flower the size of a man's hat, on the hills round Graham's Town, in the eastern part of the colony. These two tribes of plants are so limited that there is not one of either to be seen north of the mountains which bound the Great Karoo, and by much the greatest number of them grow within 100 miles of Cape Town; indeed at the distance of only 40 miles the prevailing proteaceæ are different from those at the Cape. The leucadendron argentum, or silver tree, which forms groves at the back of the Table-mountain, is confined to the peninsula of the Cape. The beautiful disa grandiflora is found only in one particular place on the top of the Table-mountain.

The dry sand of the west coast and the country northward through many degrees of latitude is the native habitation of stapelias, succulent plants with square leafless stems and flowers like star-fish, with the smell of carrion. A great portion of the eastern frontier of the Cape colony and the adjacent districts are covered with extensive thickets of a strong succulent and thorny vegetation, called by the natives the bush: similar thickets occur again far to the west, on the banks of the river Gauritz. The most common plants of the bush are aloes of many species, all exceedingly fleshy and some beautiful; the great red-flowering arborescent aloe, and some others, make a conspicuous figure in the eastern part of the colony. Other characteristic plants of the eastern districts are the spek-boem, or portulacaria afra, schotia speciosa, and the great succulent euphorbias, which grow into real trees 40 feet high, branching like a candelabrum, entirely leafless, prickly, and with a very acrid juice. The euphorbia meloformis, whose bulb, three feet in diameter, lies on the ground, to which it is attached by slender fibrous roots, is confined to the mountains of Graaf Reynet. Euphorbias, in the Old World, correspond with the cactus tribe, which belong exclusively to the New. The zamia, a singular plant, having the appearance of a dwarf-palm without any real similarity of structure, belongs to the eastern districts, especially to the great tract of bush on the Caffir frontier.

Various species of acacia are indigenous and much circumscribed in their location: the acacia horrida, or the white-thorned acacia, is very common in the eastern districts and



in Caffirland. The *acacia cafra* is strictly eastern, growing along the margins of rivers, to which it is a great ornament. The *acacia detinens*, or hook-thorn, is almost peculiar to Zand valley.

It appears from the instances mentioned, that the vegetation in the eastern districts of the colony differs from that on the western, yet many plants are generally diffused of orders and genera found only in this part of Africa. Nearly all the 300 species of the fleshy succulent tribe of *mesembryanthemum*, or Hottentot's fig; all the *oxalis*, or wood-sorrel tribe, except three in France and one in America; every species of *gladiolus*, with the exception of that in the corn-fields in Italy and France; *ixias* innumerable, one with petals of apple-green colour; *geraniums*, especially the genus *pelargonium*, or stork's bill, almost peculiar to this locality; many varieties of *gnaphalium* and *xeranthemum*; the brilliant *strelitzia*; 133 species of the house-leek tribe, all fleshy and leafless, attached to the soil by a single wiry root, and nourished from the atmosphere; *diosmas* are widely scattered in great variety; shrubby *boragines* with flowers of vivid colours, and *orchideæ* with large and showy blossoms. The leguminous plants and the *cruciferæ* of the Cape are peculiar; indeed all the vegetation has a distinct character, and both genera and species are confined within narrower limits than anywhere else, without any apparent cause to account for a dispersion so arbitrary.

Notwithstanding the peculiarity of character with which the botany of the Cape is so distinctly marked, it is connected with that of very remote countries by particular plants; for example, of the seven species of *bramble* which grow at the Cape, one is the common English *bramble* or *blackberry*. The affinity with New Holland is greater; in portions of the two countries in the same latitude there are several genera and species that are identical: *proteas* are common to both, so are several genera of *irideæ*, *leguminosæ*, *ficoideæ*, *myrtaceæ*, *Banksias*, *diosmas*, and some others. The botany of the Cape is connected with that of India, and even that of South America, by a few congeners.

The vegetation of Madagascar, though similar in many respects to the floras of India and Africa, nevertheless is its own: the *brexiaceæ* and *chlenaceæ* are orders found nowhere else; there are species of *bignonia*, *cycades*, and *zamas*, a



few of the mangosteen tribe, and in the mountains some heaths. The *hydrogetan fenestralis* is a singular aquatic plant, with leaves like the dried skeletons of leaves, having no green fleshy substance, and the *tanghinia veneniflua*, which produces a poison so deadly that its seeds are used to execute criminals, and one seed is sufficient.

Some genera and species are common and peculiar to Madagascar, the Isle of Bourbon, and Mauritius; yet of the 161 known genera in Madagascar only 54 grow on the other two islands. The three islands are rich in ferns. The *pandanus*, or screw-pine genus, abounds in Bourbon and the Mauritius, where it covers sandy plains, sending off strong aerial roots from the stem, which strike into the ground and protect the plant from the violent winds. Of 290 genera in Bourbon and Mauritius, 196 also grow in India, though the species are different: there is also some resemblance to the vegetation of South Africa, and there is a solitary genus in common with America.

Eight or ten degrees north of Madagascar lies the group of the Seychelles Islands, in which are groves of the peculiar palm which bears the double cocoanut, or coco de mer, the growth of these islands only. Its gigantic leaves are employed in the construction of houses, and other parts of the plant are applied to various domestic purposes.

## FLORA OF AUSTRALIA.

The interior of the Australian continent is so little known, that the flora which has come under observation is confined to a short distance from the coast; but it is of so strange and unexampled a character, that it might easily be mistaken for the production of another planet. Many entire orders of plants are known only in Australia, and the genera and species of others that grow elsewhere, assume new and singular forms. Evergreens, with hard narrow leaves of a sombre, melancholy hue, are prevalent, and there are whole shadowless forests of leafless trees, the foot stalks dilated and set edgewise on the stem supply their place and perform the functions of nutrition: their inverted position gives them a singular appearance. Plants in other countries have glands on the under side of the leaves, but in Australia there are glands



on both sides of these substitutes for leaves, which make them dull and lustreless, and the changes of the seasons have no influence on the unvarying olive-green of the Australian forests; even the grasses are separated from the gramineæ of other countries by a remarkable rigidity. Torres Straits, only 50 miles broad, separates this dry, sombre vegetation from the luxuriant jungle-clad shores of New Guinea, where deep and dark forests are rich in more than the usual tropical exuberance—a more complete and sudden change can hardly be imagined.

The peculiarly Australian vegetation is in the southern part of the continent of New Holland distributed in distinct foci in the same latitude, a circumstance of which the proteæ afford a remarkable instance. Nearly one-half of the known species of these beautiful shrubs grow in the parallel of Port Jackson, from which they decrease in number both to the south and the north. In that latitude, however, there are twice as many species on the eastern side of the continent as there are on the western, and four times as many as in the centre. Although the proteas at both extremities of the continent have all the characters peculiar to Australia, yet those on the eastern coast resemble the South American species, while those on the western side have a resemblance to African forms, and are confined to the same latitudes.

Species of this genus are numerous in Van Diemen's Land, where they thrive at the elevation of 3500 feet, and also on the plains. The myrtle tribe form a conspicuous feature in Australian vegetation, particularly the genera eucalyptus, melaleuca, podocarpus and others, with splendid blossoms, white, purple, yellow, crimson: 100 species of the eucalypti, most of them large trees, grow in New Holland; they form great forests in the colony of Port Jackson. The leafless acacias, of which there are 93 species, are a prominent feature in the Australian landscape. The leaves, except in very young plants, are merely foliaceous foot stalks, presenting their margin towards the stem, yet these and the eucalypti are the most leafy trees in the country. The genus casuarina, with its strange-jointed, drooping branches, called the march oak, holds a conspicuous place: they are chiefly confined to the principal parallel of this vegetation, and produce excellent timber; they grow also in the Malayan peninsula and South Sea Islands. The *oxleya xanthoxyla*, or yellow



wood, one of the cedar tribe, grows to great size, and the podocarpus asplenifolia forms a new genus of the cone-bearing trees. Some of the nettle tribe grow 15 or even 20 feet high. The epacrideæ, with scarlet, rose, and white blossoms, supply the place of heaths, which do not exist here. The purple-flowering tremandreæ, the yellow-flowering dillenia, the doryanthis excelsa, the most splendid of the lily tribe, 24 feet high, with a brilliant crimson blossom, the Banksia, the most Australian of all the proteas, with zamias of new species, are all conspicuous in the vegetation of Port Jackson.

There is a change on the eastern coast of New Holland. The castanospermum Australe is so plentiful that it furnishes the principal food of the natives; a caper-tree of grotesque form, having the colossal dimensions of the Senegal boobab, and extraordinary trees of the fig genus, characterize this region. It sometimes occurs, when the seeds of these fig-trees are deposited by birds on the iron-bark tree, or eucalyptus resinifera, that they vegetate and inclose the trunk of the tree entirely with their roots, whence they send off enormous lateral branches, which so completely envelop the tree, that at last its top alone is visible in the centre of the fig-tree, at the height of 70 or 80 feet. The pandanus genus flourishes within the influence of the sea-air. There are only six species of palms, equally local in their habitation as elsewhere, not one of which grows on the west side of the continent. The araucaria excelsa, or Norfolk Island pine, produces the best timber of any tree in this part of Australia: it extends from the parallel of  $29^{\circ}$  on the east coast towards the equator, and grows over an area of 900 square miles, including New Norfolk, New Caledonia, and other islands, some of which have no other timber tree: it is supposed to exist only within the influence of the sea. The asphodelia abound and extend to the southern extremity of Van Diemen's Land.

The south-western districts of New Holland exhibit another focus of vegetation, less rich in species than that of Port Jackson, but not less peculiar. The Kingia Australis, or grass-tree, rises solitary on the sandy plains, with bare blackened trunks as if scathed by lightning, and tufts of long grassy leaves at their extremities; Banksias, particularly the kind called wild honeysuckle, are numerous; the stylidium, whose blossoms are even more irritable than the



leaves of the sensitive mimosa, and plants with dry, everlasting blossom, characterize the flora of these districts. The greater part of the southern vegetation vanishes on the northern coasts of the continent, and what remains is mingled with the cabbage-palm, various species of the nutmeg tribe, sandal-wood, and other Malayan forms, a circumstance that may hereafter be of importance to our colonists.

Orchideæ, chiefly terrestrial, are in great variety in the extratropical regions of New Holland, and the grasses amount to one-fourth of the monocotyledonous plants. Reeds of gigantic size form forests in the marshes, and kangaroo-grass covers the plains.

Beautiful and varied as the flora is, New Holland is by no means luxuriant in vegetation. There is little appearance of verdure, the foliage is poor, the forests often shadeless, and the grass thin; but in many valleys of the mountains, and even on some parts of the plains, the vegetation is vigorous. It is not the least remarkable circumstance in this extraordinary flora, that, with the exception of a few berries, there is no edible fruit, grain, or vegetable indigenous either in New Holland or Van Diemen's Land.

The plants of New Holland prevail in every part of Van Diemen's Land; yet the coldness of the climate and the height of the mountains permit genera of the northern hemisphere to be mixed with the vegetation of the country. Butter-cups, anemonies, and polygonums of peculiar species grow on the mountain-tops, together with proteas and other Australian plants. The plains glow with the warm golden flowers of the black wattle, a mimosa emblematic of the island, and with the equally bright and orange blossom of the gorse, which perfumes the whole atmosphere. Only one tree-fern grows in this country: it rises 20 feet to the base of the fronds, which spread into an elegant top, producing a shadow gloomy as night-fall, and there are 150 species of orchis. The southern extremities both of New Holland and Van Diemen's Land are characterized by the prevalence of evergreen plants: but the trees here, as well as in the other parts of the southern hemisphere, do not shed their leaves periodically as with us.

The botany of New Zealand appears to be intimately allied to that of New Holland, South America, and South Africa, but chiefly to that of New Holland. Noble trees



form impenetrable forests, sixty of which yield the finest timber, and many are of kinds to which we have nothing similar. Here there are no representatives of our oak, birch, or willow, but five species of beech and ten of pine have been discovered that are peculiar to the country. They are all alpine, and only descend to the level of the sea in the northern parts of the islands. The pines of the southern hemisphere are more local than in the northern; of the ten species peculiar to New Zealand it is not certain that more than two or three are found in the middle island, or that any of them grow south of the 40th parallel. The Kauri pine, or *dammara australis*, is indigenous in all the three islands, but it is the only cone-bearing tree in North Island, where it grows in hilly situations near the sea, shooting up with a clean stem 60 or 90 feet, sometimes 30 feet in diameter, with a spreading but thin top, and generally has a quantity of transparent yellow resin imbedded at its base. This fine tree does not grow beyond the 38° S. lat. The *metrosideros tomentosa*, with rich crimson blossoms, is one of the greatest ornaments of the forests, and the *metrosideros robusta* the most singular. It grows to a very great size, and sends shoots from its trunk and branches to the ground, which become so massive that they support the old stem, which to all appearance loses its vitality; it is in fact an enormous epiphyte, growing to and not from the ground. Many of the smaller trees are of the laurel tribe, with poisonous berries. Besides there is the cabbage palm, the *areca sapida*, elder, the *fuchsia excortica*, and other shrubs. Before New Zealand was colonized, the natives lived chiefly on the roots of the edible fern, *pteris esculenta*, with which the country is densely covered, mixed with a shrub that grows like a cypress, and the tea-plant, which is a kind of myrtle whose berries afford an intoxicating liquor. More than 90 species of fern are natives of these islands, some of which are arborescent and 40 feet high; the country is chiefly covered with these and with the New Zealand flax, *phormium tenax*, which grows abundantly both on the mountains and plains.

In Norfolk Island 152 species of plants are already known, and many, no doubt, are yet to be discovered. The *araucaria excelsa* and some palms are indigenous, and there are three times as many ferns as of all the other plants together.



The multitude of islands of Polynesia constitute a botanical region apart from all others, though it is but little varied, and characterized principally by the number of syngenesious plants with arborescent forms and tree-ferns. There are 50 varieties of the bread-fruit, which produce three or four crops in the year, and supply the natives with food, clothing, and timber; the cocoa-nut palm and the banana are on all the islands, and the pandanus, which thrives only when exposed to the sea-air. The *tacca pinnatifida* yields arrow-root; an intoxicating liquor is made from the fruit of one of the *dracæna* tribe, and the inner bark of the *morus papyrifera* is manufactured into cloth. Besides the cocoa-nut palm and pandanus, various trees grow on the coral islands, among others the fragrant *suriana* and the sweet-scented *Tournefortia*.

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## CHAPTER XXV.

### AMERICAN VEGETATION—FLORA OF NORTH, CENTRAL, AND SOUTH AMERICA — ANTARCTIC FLORA — MARINE VEGETATION.

FROM similarity of physical circumstances the arctic flora of America bears a strong resemblance to that of the northern regions of Europe and Asia. This botanical district comprises Greenland, and extends considerably to the south of the arctic circle, especially at the eastern and western ends of the continent, where it reaches the 60th parallel of N. lat., and even more; it is continued along the tops of the Rocky Mountains almost to Mexico, and it re-appears on the White Mountains and a few other parts of the Alleghanies.

Greenland has a much more arctic flora than Iceland; the valleys are entirely covered with mosses and marsh plants, and the gloomy rocks are cased in sombre lichens that grow under the snow, and the grasses on the pasture-grounds that line the fiords are nearly four times less varied than those of Iceland. In some sheltered spots the service-tree bears fruit, and birches grow to the height of a few feet; but ligneous plants in general trail on the ground.



The arctic flora of America has much the same character with those of Europe and Asia, and many species are common to all; still more are representative, but there is a difference in the vegetation at the two extremities of the continent; there are 30 species in the east and 20 in the west end which grow nowhere else. The sameness of character changes with the barren treeless lands at the verge of the Arctic region, and the distribution of plants varies both with the latitude and the longitude. Taking a broad view of the botanical districts of North America, there are two woody regions, one on the eastern, the other on the western side of the continent, separated by a region of prairies where grasses and herbaceous plants predominate. The vegetation of these three parts, so dissimilar, varies with the latitude, but not after the same law as in Europe, for the winter is much colder, and the summer warmer, on the eastern coasts of America than on the western coast of Europe, owing in a great measure to the prevalence of westerly winds which bring cold and damp to our shores.

Boundless forests of black and white spruce with an undergrowth of reindeer moss cover the country south of the Arctic region, which are afterwards mixed with other trees; gooseberries, strawberries, currants, and some other plants thrive there. There are vast forests in Canada of pines, oak, ash, hiccory, red beech, birch, the lofty Canadian poplar, sometimes 100 feet high and 36 feet in circumference, and sugar maple; the prevailing plants are kalmias, azaleas, and asters, the former vernal, the latter autumnal; solidagos and asters are the most characteristic plants of this region.

The splendour of the North American flora is displayed in the United States; the American sycamore, chestnut, black walnut, hiccory, white cedar, wild cherry, red birch, locust-tree, tulip-tree or liriodendron, the glory of American forests, liquid-ambar, oak, ash, pine-trees of many species, grow luxuriantly with an undergrowth of rhododendrons, azaleas, andromedas, gerardias, calycanthus, hydrangea, and many more of woody texture, with an infinite variety of herbaceous and climbing plants.

The vegetation is different on the two sides of the Alleghany Mountains; the locust-tree, Canadian poplar, hibiscus, and hydrangea, are most common on the west side: the American chestnut and kalmias are so numerous on the



Atlantic side, as to give a distinctive character to the flora, here too aquatic plants are more frequent, among these the *saracenia* or pitcher-plant, singular in form, with leaves like pitchers covered with a lid, half-full of water.

The autumnal tints of the forests in the middle States are beautiful and of endless variety; the dark leaves of the evergreen pine, the red foliage of the maple, the yellow beech, the scarlet oak, and purple *nyssa*, with all their intermediate tints, ever changing with the light and distance, produce an effect at sunset that would astonish the native of a country with a more sober-coloured flora under a more cloudy sky.

In Virginia, Kentucky, and the southern States the vegetation assumes a different aspect, though many plants of more northern districts are mixed with it. Trees and shrubs here are remarkable for broad shining leaves and splendid blossoms, as the *gleditschia*, *catalpa*, *hibiscus*, and all the family of *magnolias*, which are natives of the country, excepting a very few found in Asia and the Indian islands. They are the distinguishing feature of the flora from Virginia to the Gulf of Mexico, and from the Atlantic to the Rocky Mountains: the *magnolia grandiflora* and the tulip-tree are the most splendid specimens of this race of plants; the latter is often 120 feet high. The long-leaved pitch-pine, one of the most picturesque of trees, covers an arid soil on the coast of the Atlantic of 60,000 square miles. The swamps so common in the southern States are clothed with gigantic deciduous cypress, the aquatic oak, swampy hiccory, with the magnificent *nelumbeum luteum* and other aquatics, and among the innumerable herbaceous plants the singular *dionæa muscipula*, or American fly-trap; the trap is formed by two opposite leaves, covered with spines so irritable, that it instantly closes upon the insect that has come to suck its sweet juice. This *magnolia* region corresponds in latitude with the southern shores of the Mediterranean, but the climate is hotter and more humid, in consequence of which there is a considerable number of Mexican plants. A few dwarf-palms appear among the *magnolias*, and the forests in Florida and Alabama are covered with *tillandsia usneoides*, an air-plant, which hangs from the boughs.

Ten or twelve species of grass cover the extensive prairies or steppes of the valley of the Mississippi. The forms of



the Tartarian steppes appear to the north in the centaurea, artemisia, astragali, but the dahlias, ænotheras, with many more, are their own. The helianthus and coreopsis, mixed with some European genera, mark the middle regions: and in the south towards the Rocky Mountains, Clarkias and Bartonias are mixed with the Mexican genera of cactus and yucca. The western forest is less extensive and less varied than the eastern, but the trees are larger. This flora in high latitudes is but little known; the thuya gigantea on the Rocky Mountains and the coast of the Pacific is 200 feet high. Claytonias and currants, with plants of northern Asia, are found here.

Farther south the pinus Lambertiana is another specimen of the stupendous trees of this flora; seven species of it are indigenous in California, some of which have measured 200, and even 300 feet high, and 80 in circumference. Captain Belcher, in his 'Voyage on the Pacific,' mentions having measured an oak 27 feet in circumference, and another 18 feet girth at the height of 60 feet from the ground, before the branches began to spread. This is the native soil of the currant-bushes with red and yellow blossoms, of many varieties of lupins, peonies, poppies, and other herbaceous plants so ornamental in our gardens.

There are 332 genera of plants peculiar to North America, exclusive of Mexico, but no family of any great extent has yet been discovered there. About 160 large trees yield excellent timber; the wood of the pine-trees of the eastern forests is of inferior quality to that grown on the other side of the continent, and both appear to be less valuable than the pine-wood of Europe, which is best when produced in a cold climate. The pinus cembra and the pinus uncinata are the most esteemed of the Old World.

The native fruit of North America are mostly of the nut-kind, and there are many of these, to which may be added the Florida orange, the chicasa plum, the papaw, the banana, the red mulberry, and the plum-like fruit of the persimmon. There are seven species of wild grapes, but good wine has not hitherto been produced. Although America has contributed so much to the ornament of our pleasure-grounds and gardens, yet there is not one North American plant which has become an object of extensive cultivation, while America has borrowed largely from other parts of the globe;



the grapes cultivated in North America are European ; tobacco, Indian corn, and many others of the utmost commercial value are strangers to the soil, having been introduced by the earliest inhabitants from Mexico and South America, which have contributed much more to general utility.

### MEXICAN FLORA.

Mexico unites the vegetation of North and South America, though it resembles that of the latter more nearly. Whole provinces on the table-land and mountains produce alpine plants, oaks, chestnuts, and pines spontaneously. The edible rooted nasturtium and the tuberous-rooted sorrel are peculiar. The cheirostemon, or hand-tree, so named from the resemblance its stamens bear to the foot of a bird of prey, grows here, and also in the Guatimala forests.

The low-lands of Mexico and Central America have a very rich flora, consisting of many orders and genera peculiar to them, and species without number, a great portion of which are unknown. The hymenea courbaril, from which the copal of Mexico is obtained, logwood, mahogany, and many other large trees, valuable for their timber, grow in the forests; sugar-cane, tobacco, indigo, aloe, yam, capsicum, and yucca are indigenous in Mexico and Central America. It is the native region of the melastomas, of which 620 species grow here; almost all the pepper tribe, the passifloræ, the ornament and pride of tropical America and the West Indian islands, begin to be numerous in these regions. The pineapple is entirely American, growing in the woods and savannahs: it has been carried to the West Indies, to the East Indies and China, and is naturalized in all. This country has also produced the cherimoya, said to be the most exquisite of fruit. Hot arid tracts are covered with the cactus tribe, a plant of Central America and Mexico, which is more widely dispersed than the anana: some species bear a considerable degree of cold. They are social plants, inhabiting sandy plains in thickets, and of many species: their forms are various, and their blossoms beautiful. A few occur at a considerable distance from the tropics, to the north and the south. The night-flowering cereus grows in all its beauty in the arid parts of Chili, filling the night air



with its perfume. The cactus opuntia grows in the Rocky Mountains; and Sir George Back found a small island in the Lake of the Woods covered with it. This species has been brought to Europe, and now grows a common weed on the borders of the Mediterranean. In Mexico, the cochineal insect was collected from the cactus coccinellifer long before the Spanish conquest. There are large fields of American aloe, from which a liquor called pulque, and also an ardent spirit, are made. The ancient Mexicans made their hemp from this plant, and also their paper; and they used its thorns for nails. The forests of Panama contain at least 97 different kinds of trees, which grow luxuriantly in a climate where the torrents of rain are so favourable to vegetation, and so unfavourable to life that the tainted air is deadly even to animals. The flora of each West Indian island is similar to that of the continent opposite to it. The myrtus pimento, producing alspice, is common in the hills: cloves, nutmeg, custard-apple, guava, mango, the avocado pear, and tobacco are indigenous; the cabbage-palm grows to the height of 200 feet; the palma-real of Cuba is the most majestic of that noble family; and in Barbadoes there still exists a tree, but wearing out rapidly, which has given the island its name.

### FLORA OF TROPICAL AMERICA.

Although the flora of tropical America is better known than that of Asia or Africa, there must still be thousands of plants of which we have no knowledge: and those which have come under observation are so varied and so numerous, that it is not possible to convey an idea of the peculiarities of this vegetation, or of the extent and richness of its woodlands. The upper Orinoco flows for some hundred miles chiefly through forests; and the silvas of the Amazons are six times the size of France. In these the trees are colossal, and the vegetation so matted together by underwood, creeping and parasitical plants, that the sun's rays can scarcely penetrate the dense foliage.

These extensive forests are by no means uniform; they differ on each side of the equator, though climate and other circumstances are the same. Venezuela, Guiana, the Amazons, and Brazil, are each the centre of a peculiar flora. So partial



is this splendid vegetation, that almost each tributary of the great rivers has a flora of its own, particular families of plants are so restricted in their localities, and predominate so exclusively where they occur, that they change the appearance of the forest. Thus from the prevalence of the orders laurinae, sapotaceae, and others, which have leathery, shining, and entire leaves, the forests through which the Rio Negro, Cassiquiare, and Tuamine flow, differ in aspect from those of the other affluents of the Amazons. Even the grassy llanos, so uniform in appearance, have their centres of vegetation; and only agree with the pampas of Buenos Ayres in being covered with grass and herbs. In these tropical regions the flora varies with the altitude also. On the Andes, almost at the limit of vegetation, the ground is covered with purple, azure, and scarlet gentians, drabas, alchemillas, and many other brilliantly coloured alpine plants. This zone is followed by thickets of coriaceous-leaved plants, in perpetual bloom and verdure; and then come the forest-trees. Arborescent ferns ascend to 7000 feet; the coffee-tree and palms to 5000; and neither indigo nor cocoa can be cultivated lower than 2000.

Many parts of the coasts of Venezuela and Guiana are rendered pestilential by the effluvia of the mangrove, avicenna, and the manchineel, one of the euphorbia family, consisting of 562 species in tropical America, all having milky juice, deleterious in the greater number. The well-known poison curara is prepared by the Indians of Guiana from the fruit and bark of the bertholletia, of the order strychnae, than which nature has probably produced no plants more deadly. The ourari is a creeping plant which yields the deadly wourali, the powerful effect of which was proved by Mr. Waterton's experiments.

The cinchona, or true bark-tree, grows only on the Cordilleras of the Andes. Medicinal qualities exist in other plants of different genera in Guiana, as the cusparia carony, which produces Angustura bark, and others with similar properties. The sapindus saponaria, or soap-tree, is used by the natives for washing. Capsicum, vanilla, the hoyá, or incense plant, the dipterix odorat, whose fruit is the tonqua-bean, and the casada or mandioc, are natives of the country. The cow-tree, almost confined to the Cordillera of the coast of Venezuela, yields such abundance of nutri-



tious milky juice that it is carried in pails like milk from the cow. The chocolate-palm, the cacao-shrub, fruit of the most excellent flavour, plants yielding balsam, resin, and gum, are numerous in the tropical regions. There the laurel tribe assume the character of majestic trees; some are so rich in oil, that it gushes from a wound in the bark. One of these laurels produces the essential oil which dissolves caoutchouc, or Indian rubber, used in rendering cloth water-proof.

Plantains of gigantic size form large forests: but palms are the most numerous and the most beautiful of all the trees in these countries. There are 90 species of them; and they are so local that a change takes place every 50 miles. They are the greatest ornament of the upper Orinoco.

The llanos of Venezuela and Guiana are covered with tall grass, mixed with lilies and other bulbous flowers, the sensitive mimosa, and palms constantly varying in species.

No language can describe the glory of the forests of the Amazons and Brazil, the endless variety of form, the contrasts of colour and size: there even the largest trees bear brilliant blossoms; scarlet, purple, blue, rose colour, and golden yellow, are blended with every possible shade of green. Majestic trees, as the bombax ceiba, the dark-leaved mora with its white blossoms, the fig, cashew and mimosa tribes, which are here of unwonted dimensions, and a thousand other giants of the forest, are contrasted with the graceful palm, the delicate acacia, reeds of a hundred feet high, grasses of 40, and tree-ferns in myriads. Passifloreæ and slender creepers twine round the lower plants, while others as thick as cables climb the lofty trees, drop again to the ground, rise anew and stretch from bough to bough, wreathed with their own leaves and flowers, and studded with the vividly coloured blossoms of the orchideæ. An impenetrable and everlasting vegetation covers the ground; decay and death are concealed by the exuberance of life; the trees are loaded with parasites while alive; they become masses of living plants when they die.

One twenty-ninth part of the flowering plants of the Brazilian forests are of the coffea tribe, and the rose-coloured and yellow-flowering bignonias are among their greatest ornaments, where all is grace and beauty. Thousands of herbs and trees must still be undescribed, where each stream has



its own vegetation. In those parts of Brazil less favoured by nature the forests consist of stunted deciduous trees, and the boundless plains have grasses, interspersed with myrtles and other shrubs.

The forests of Paraguay and Vermejo, in La Plata, are almost as rich as those of the tropics. Noble trees furnish timber and fruit; the algaroba, a kind of acacia, produces clusters of a bean, of which the Indians make bread; and also a strong fermented liquor; the palm and cinchona grow there; and the Yerba-maté, the leaves of which are universally used as tea in South America, and were in use before the Spanish conquest.

The sandy deserts towards the mountains are the land of the aloe and cactus in all their varieties. The fibres of the aloe are made into cordage by the Indians, for fishing-nets and other uses, and the juice affords them drink. Some larger species of cactus give durable wood; and the cochineal insect, which feeds on them, is a valuable article of commerce.

Grass, clover, and the domiciled European and African thistles, with a solitary ombu at wide intervals, are the unvarying features of the pampas; and thorny stunted bushes, characteristic of all deserts, are the only vegetation of the Patagonian shingle. But on the mountain valleys in the far south may be seen the winter's-bark, arbutus, new species of beech-trees, stunted berberries and misodendrons, which are singular kinds of parasitical plants.

Large forests of *araucaria imbricata* grow in the Andes of Chili and Patagonia. This tall and handsome pine, with cones the size of a man's head, supplies the natives with a great part of their food. It is said that the fruit of one large tree will maintain eighteen persons for a year.

Nothing grows under these great forests; and when accidentally burnt down in the mountainous parts of Patagonia, they never rise again, but the ground they grew on is soon covered with an impenetrable bushwood of dwarf oak. In Chili the violently stinging *loasa* appears first in these burnt places, bushes grow afterwards, and then comes a tree grass, 18 feet high, of which the Indians make their huts. The new vegetation that follows the burning of primeval forests is quite unaccountable. The ancient and undisturbed forests of Pennsylvania have no undergrowth, and when burnt down they are succeeded by a thick growth of rhododendrons.



The southern coasts of Chili are very barren, and all plants existing there, even the herbaceous, have a tendency to assume a hard knotty texture. The stem of the wild potato, which is indigenous, becomes woody and bristly as it grows old. It is a native of the sea strand, and is never found more than 400 feet above it. In its wild state the root is small and bitter; it is one of many instances of the influence of cultivation in rendering unpromising plants useful to man.

Although the coast is barren, and the flora, at an elevation of 9000 feet on the Chilian Andes, almost identical with that of the Straits of Magellan, yet the climate is so mild in some valleys, especially that of Antuco, that the vegetation is semi-tropical. In it broad-leaved and bright-coloured plants, and the most fragrant and brilliant orchideæ, are mixed with the usual alpine genera. Dr. Pœppig says, that whatever South Africa or New Holland can boast of in beauty, in variety of form, or brilliancy of colour, is rivalled by the flora in the highest zone in this part of the Andes, even up to the region of perpetual snow; and, indeed, it bears a strong analogy to the vegetation of both these countries.

The humidity or dryness of the prevailing winds makes an immense difference in the character of the countries on each side of the Andes. In Peru they are bare of plants on the western side, while on the east there is exuberant vegetation; but it gradually disappears with the increasing height, till at an elevation of 13,782 feet arborescent plants vanish, and alpine races, of the most vivid beauty, succeed; which, in their turn, give place to the grasses at the height of 16,138 feet. Above these, in the dreary plains of Bombon, and other lands of the same altitude, even the thinly-scattered mosses are sickly; and at the height of 21,878 feet the snow-lichen forms the last show of vegetable life; confirming the observation of Don Ulloa, that the produce of the soil is the thermometer of Peru.

## ANTARCTIC FLORA.

Tierra del Fuego and Kerguelen's Islands are the northern boundary of the antarctic lands, which are scattered round the south pole at immense distances from one another. On these the vegetation decreases as the latitude increases, till



at length utter desolation prevails; not a lichen covers the dreary storm-beaten rocks; not a sea-weed lives in the gelid waves. In the arctic regions, on the contrary, no land has yet been discovered that is entirely destitute of vegetable life. This remarkable difference does not so much depend on a greater degree of cold in winter as on the want of warmth in summer. In the high northern latitudes, the power of the summer sun is so great as to melt the pitch between the planks of the vessels; while in corresponding southern latitudes Fahrenheit's thermometer does not rise above  $14^{\circ}$  at noon, at a season corresponding to our August. The perpetual snow comes to a much lower latitude in the southern lands than it does in the north. Sandwich Land, in a latitude corresponding to that of the north of Scotland, is perpetually covered with many fathoms of snow. A single species of grass, the *aira antarctica*, is the only flowering plant in the South Shetland Islands, which are no less ice-bound; and Cockburn Island, one of that group, in the 60th parallel, contains the last vestiges of vegetation; while the namesake islands, in an equally high latitude, to the north of Scotland, are inhabited and cultivated; nay, South Georgia, in a latitude similar to that of Yorkshire, is always clad in frozen snow, and only produces some mosses, lichens, and wild burnet; while Iceland, 10 degrees nearer the pole, has 870 species, more than half of which are flower-bearing.

The forest-covered islands of Tierra del Fuego are only 360 miles from the desolate Shetland group. Such is the difference that a few degrees of latitude can produce in these antarctic regions, combined with an equable climate and excessive humidity. The prevalence of evergreen plants is the most characteristic feature in the Fuegian flora. Densely entangled forests of winter's bark, and two species of beech-trees, grow from the shore to a considerable height on the mountains. Of these, the *fagus deltoides*, which never loses its brownish-green leaves, prevails almost to the exclusion of the evergreen winter's bark and the deciduous beech, which is very beautiful. There are dwarf species of *arbutus*, the *myrtus nummularia*, which is used instead of tea, besides *berberry*, *currant*, and *fuchsia*. Peculiar species of *ranunculi*, *calceolarias*, *caryophyllæ*, cruciform plants and violets. Wild celery and scurvy grass are the only edible plants; and a bright yellow fungus, which grows on the beech-trees,



forms a great part of the food of the natives. There is a greater number of plants in Tierra del Fuego, either identical with those in Great Britain, or representatives of them, than exists in any other country in the southern hemisphere. The sea-pink, or thrift, the common sloewort, *primula hirsuta*, and at least thirty other flowering plants, with almost all the lichens, 48 mosses, and many other plants of the cryptogamous kinds, are identically the same; while the number of genera common to both countries is still greater, and though unknown in the intermediate latitudes, reappear here. Hermite Island, west from Cape Horn, is a forest land, covered with winter's bark and the Fuegian beeches; and is the most southern spot on earth on which arborescent vegetation is found. An alpine flora, many of them of European genera, grows on the mountains; succeeded higher up by mosses and lichens. Mosses are exceedingly plentiful throughout Fuegia; but they abound in Hermite Island more than in any other country, of singular and beautiful kinds.

Although the Falkland Islands are in a lower latitude than Tierra del Fuego, not a tree is to be seen. The *veronica elliptica*, resembling a myrtle, which is extremely rare, and confined to West Falkland, is the only large shrub; a white flowering plant, like an aster, about four feet high, is common; while a bramble, a crowberry, and a myrtle, bearing no resemblance, however, to the European species, trail on the ground, and afford edible fruit. The balsam bog, or *bolax glebaria*, and grasses, form the only conspicuous feature in the botany of these islands; and, together with rushes and *Dactylis Cæspitosa*, or Tussock grass, cover them, almost to the exclusion of other plants. The *bolax* grows in tufted hemispherical masses, of a yellow-green colour, and very firm substance, often four feet high, and as many in diameter, from whence a strong-smelling resinous substance exudes perceptible at a distance. This plant has umbelliferous flowers, and belongs to the carrot order, but forms an antarctic genus quite peculiar.

The tussock grass is the most useful and the most singular plant in this flora. It covers all the small islands of the group, like a forest of miniature palm-trees, and thrives best on the shores exposed to the spray of the sea. Each tussock is an isolated plant, occupying about two square yards of ground. It forms a hillock of matted roots, rising straight



and solitary out of the soil, often six feet high and four or five in diameter ; from the top of which it throws out a thick grassy foliage of blades, six feet long, drooping on all sides, and forming with the leaves of the adjacent plants an arch over the ground beneath, which yields shelter to sea-lions, penguins, and petrels. Cattle are exceedingly fond of this grass, which yields annually a much greater supply of excellent fodder than the same extent of ground would do either of common grass or clover. Both the tussock grass and the bolax are found, though sparingly, in Tierra del Fuego ; indeed, the vegetation of the Falkland Islands consists chiefly of the mountain plants of that country, and of those that grow on the arid plains of Patagonia ; but it is kept close to the ground by the fierceness of the terrific gales that sweep over these antarctic islands. Peculiar species of European genera are found here, as a *calceolaria*, wood sorrel, and a yellow violet, with the shepherd's purse, *cardamine hirsuta*, and the *primula farinosa*, appear to be identical with those at home. In all there are scarcely 120 flowering plants, including grasses. Ferns and mosses are few, but lichens are in great variety and abundance, among which many are identical with those in Britain.

In the eastern hemisphere, far, far removed from the Falkland group, the Auckland Islands lie in the boisterous ocean south of New Zealand. They are covered with dense and all but impenetrable thickets of stunted trees, or rather shrubs, about 20 or 30 feet high, gnarled by gales from a stormy sea. There is nothing analogous to these shrubs in the northern hemisphere ; but the *veronica elliptica*, a native of Tierra del Fuego and New Zealand, is one of them. Fifteen species of ferns find shelter under these trees, and their fallen trunks are covered with mosses and lichens. Eighty flowering plants were found during the stay of the discovery ships, of which fifty-six are new ; and half of the whole number are peculiar to this group and to Campbell's Island. Some of the most beautiful flowers grow on the mountains, others are mixed with the ferns in the forests. A beautiful plant was discovered, like a purple aster, a *veronica*, with large spikes of ultramarine colour ; a white one, with a perfume like jessamine ; a sweet-smelling alpine *hierochloe* ; and in some of the valleys the fragrant and bright-yellow blossoms of a species of *asphodel* were so



abundant that the ground looked like a carpet of gold. A singular plant grows on the sea-shore, having bunches of green waxy blossoms the size of a child's head. There are also antarctic species of European genera, as beautiful red and white gentians, geraniums, &c. The vegetation is characterized by an exuberance of the finer flowering plants, and an absence of grasses and sedges ; but the landscape, though picturesque, has a sombre aspect, from the prevalence of brownish-leaved plants of the myrtle tribe.

Campbell's Island lies 120 miles to the south of the Auckland group, and is much smaller, but from the more varied form of its surface it is supposed to produce as many species of plants. During the two days the discovery ships, under the command of Sir James Ross, remained there, between 200 and 300 were collected, of which 66 were flowering plants, 14 of which were peculiar to the country. Many of the Auckland Island plants were found here, yet a great change had taken place ; 34 species had disappeared and were replaced by 20 new, all peculiar to Campbell's Island alone, and some were found that hitherto had been supposed to belong to Antarctic America only. In the Auckland group only one-seventh of the plants are common to other Antarctic lands, whilst in Campbell's Island a fourth are natives of other longitudes in the Antarctic Ocean. The flora of Campbell's Island and the Auckland group is so intimately allied to that of New Zealand, that it may be regarded as the continuation of the latter, under an Antarctic character, though destitute of the beech and pine trees. There is a considerable number of Fuegian plants in the islands under consideration, though 4000 miles distant, and whenever their flora differs in the smaller plants from that of New Zealand, it approximates to that of Antarctic America ; but the trees and shrubs are entirely dissimilar. The relation between this vegetation and that of the northern regions is but slight. The Auckland group and Campbell's Island are in a latitude corresponding to that of England, yet only three indigenous plants of our island have been found in them, namely, the *cardamine hirsuta*, *montia*, and *callitriche*. This is the utmost southern limit of tree-ferns.

Perhaps no spot in either hemisphere, at the same distance from the pole, is more barren than Kerguelen Islands, lying in a remote part of the south polar oceans. Only 18



species of flowering plants were found there, which is less than the number in Melville Island, in the Arctic Seas; and three times less than the number even in Spitzbergen. The whole known vegetation of these islands only amounts to 150, including sea-weeds. The pringlea, a kind of cabbage, acceptable to those who have been long at sea, is peculiar to the island, and grass, together with a plant similar to the bolax of the Falkland Islands, covers large tracts. About 20 mosses, lichens, &c., are only found in these islands, but many of the others are also native in the European Alps, and north polar regions. It is a very remarkable circumstance in the distribution of plants, that there should be so much analogy between the floras of places so far apart as Kerguelen Islands, the groups south from New Zealand, the Falkland Islands, South Georgia, and Tierra del Fuego.

### MARINE VEGETATION.

A vegetable world lies beneath the surface of the ocean, altogether unlike that on land, and existing under circumstances totally different with regard to light, heat, and pressure, yet sustained by the same means. Carbonic acid and ammonia are as essential, and metallic oxides are as indispensable to marine vegetation as they are to land plants. Sea water contains ammonia, and something more than a twelve-thousandth part of its weight of carbonate of lime, yet that minute portion is sufficient to supply all the shellfish and coral insects in the sea with materials for their habitations, as well as food for vegetation. Marine plants are more expert chemists than we are, for the water of the ocean contains rather less than a millionth part of its weight of iodine, which they collect in quantities, impossible for us to obtain otherwise than from their ashes.

Sea-weeds fix their roots to any thing; to stone, wood, and to other sea-weeds: they must therefore derive all their nourishment from the water, and the air it contains; and the vital force or chemical energy by which they decompose and assimilate the substances fit for their maintenance, is the sun's light.

Flower-bearing sea-weeds are very limited in their range, which depends upon the depth of water and the nature of the



coasts, but the cryptogamic kinds are widely dispersed; some species are even found in every climate from pole to pole.

Marine vegetation varies both horizontally and vertically with the depth, and it seems to be a general law throughout the ocean that the light of the sun and vegetation end together; it consequently depends on the power of the sun and the transparency of the water; so different kinds of sea-weeds affect different depths, where the weight of the water, the quantity of light and heat, suits them best. One great marine zone lies between the high and low water marks, and varies in species with the nature of the coasts, but exhibits similar phenomena throughout the northern hemisphere. In the British seas, where, with two exceptions, the whole flora is cryptogamic, this zone does not extend deeper than 30 fathoms, but is divided into two distinct provinces, one to the south and another to the north. The former includes the southern and eastern coasts of England, the southern and western coasts of Ireland, and both the channels; while the northern flora is confined to the Scottish seas and the adjacent coasts of England and Ireland. The second British zone begins at low-water mark, and extends below it to a depth from 7 to 15 fathoms. It contains the great tangle sea-weeds, growing in miniature forests, mixed with fuci, and is the abode of a host of animals. The nulliflora, a coral-like sea-weed, is the last plant of this zone, and the lowest in these seas, where it does not extend below the depth of 60 fathoms, but in the Mediterranean it is found at 70 or 80 fathoms, and is the lowest plant in that sea. The same law prevails in the Bay of Biscay, where one set of sea-weeds is never found lower than 20 feet below the surface; another only in the zone between the depths of 5 and 30 feet; and another between 15 and 35 feet. In these two last zones they are most numerous; at a greater depth the kinds continue to vary, but their numbers decrease. The seeds of each kind float at the depth most genial to the future plant; they must therefore be of different weights. The distribution in the Egean Sea was found by Professor E. Forbes to be perfectly similar, only that the vegetation is different, and extends to a greater depth in the Mediterranean than in more northern seas. He also observes that sea-weeds growing near the surface are more limited in their distribution than those that grow lower down, and that with regard to vegeta-



tion depth corresponds with latitude, as height does on land. Thus the flora at great depths, in warm seas, is represented by kindred forms in higher latitudes. There is every reason to believe that the same laws of distribution prevail throughout the ocean and every sea.

Two genera of weeds inhabit the sea: a jointed kind, which includes the confervæ, which are plants having a thread-like form; and the jointless kind, to which belong dulse, laver, the kinds used for making kelp, vegetable glue, and iodine; that in the Indian Archipelago of which the sea-swallow makes the edible nests; and all the huge species which grow in submarine forests, or float like green meadows in the open ocean.

Sea-weeds adhere firmly to the rocks before their fructification, but they are easily detached afterwards, which accounts for some of the vast fields of floating weeds; but others, of gigantic size and wide distribution, are supposed to grow unattached in the water itself. There are permanent bands of sea-weed in our British Channel, and in the North Sea, of the kind called *felum*, which grows abundantly on the western coasts of the Channel, and they lie in the direction of the currents, in beds 15 or 20 miles long, and not more than 600 feet wide. These bands must oscillate with the tides between two corresponding zones of rest, one at the turn of the flood, and the other at the turn of the ebb. It is doubtful whether the *fucus natans* or *sargassum bucciforum* grows on rocks at the bottom of the Atlantic, between the parallels of 40° north and south of the equator, and when detached, is drifted uniformly to particular spots which never vary; or whether it is propagated and grows in the water; but the mass of that plant, west of the Azores, occupies an area equal to that of France, and has not changed its place since the time of Columbus. Fields of the same kind cover the sea at the Bahama Islands and other places, and two new species of it were discovered in the Antarctic seas.

The *macrocystis pyrifera* and the *laniaria radiata* are the most remarkable of marine plants for their gigantic size and the extent of their range. They were met with on the Antarctic coasts, two degrees nearer the south pole than any other vegetable production, forming the utmost limit of vegetable life in the south polar seas. The *macrocystis*



pyrifera exists in vast detached masses, like green meadows, in every latitude from the south polar ocean to the 45th degree N. lat. in the Atlantic, and to the shores of California in the Pacific, where there are fields of it so impenetrable, that it has saved vessels driven by the heavy swell towards that shore from shipwreck. It is never seen where the temperature of the water is at the freezing-point, and is the largest of the vegetable tribe, being occasionally 300 or 400 feet long. The laminaria abounds off the Cape of Good Hope and in the Antarctic Ocean. These two species form great part of a band of sea-weed that girds Kerguelen Islands so densely, that a boat can scarcely be pulled through it, and they are found in great abundance on the coasts of the Falkland group, and also in vast fields in the open sea, hundreds of miles from any land; had it ever grown on the distant shores, it must have taken ages to travel so far, drifted by the wind, currents, and sand of the seas. The red, green, and purple lavers of Great Britain are found on the coasts of the Falkland Islands, and though some of the northern weeds are not found in the intervening warm seas, they re-appear here. The lessonia is the most remarkable marine plant in this group of islands. Its stems, much thicker than a man's leg, and from 8 to 10 feet long, fix themselves by clasping fibres to the rocks beyond the high-water mark. Many branches shoot upwards from these stems, from which long leaves droop into the water like willows. There are immense submarine forests off Patagonia and Tierra del Fuego, attached to the rocks at the bottom. These plants are so strong and buoyant, that they bring up large masses of stone, and as they grow slanting, and stretch along the surface of the sea, they are sometimes 300 feet long. The quantity of living creatures which inhabit these marine forests and the parasitical weeds attached to them is inconceivable, they absolutely teem with life.

Great patches of *confervæ* are occasionally met with in the high seas. Bands several miles long, of a reddish-brown species, like chopped hay, occur off Bahia, on the coast of Brazil; the same plant is said to have given the name to the Red Sea; and different species are common in the Australian seas.



## CHAPTER XXVI.

## DISTRIBUTION OF INSECTS.

THREE hundred thousand insects are known: some with wings, others without; some are aquatic, others are aquatic only in the first stage of their existence; and many are parasitical. Some land insects are carnivorous, others feed on vegetables; some of the carnivorous tribe live on dead, others on living animals, but they are not half so numerous as those that live on vegetables. Some change as they are developed; in their first stage they eat animal food, and vegetables when they come to maturity. Insects increase in kinds and in numbers from the poles to the equator: in a residence of eleven months in Melville Island, Sir Edward Parry found only six species, because lichens and mosses do not afford nourishment for the insect tribes, though it is probable that every other kind of plant gives food and shelter to more than one species; it is even said that 40 different insects are quartered upon the common nettle.

The increase of insects from the poles to the equator does not take place at the same rate everywhere. The polar regions and New Holland have very few specifically and individually; they are more abundant in North Africa, Chili, and the sandy deserts west from Brazil; North America has fewer species than Europe in the same latitude, and Asia has few varieties of species in proportion to its size; Europe, especially Germany, produces many more species than intertropical Africa; Caffraria, the African and Indian Islands, are nearly the same as to species; but by far the richest of all, both in species and numbers, are central and intertropical America. Beetles are an exception to the law of increase towards the equator, as they are infinitely more numerous in species in the temperate regions of the northern hemisphere than in equatorial countries. The location of insects depends upon that of the plants which yield their food; and as almost each plant is peopled with inhabitants peculiar to itself, insects are distributed over the earth in



the same manner as vegetables; the groups consequently are often confined within narrow limits, and it is extraordinary that, notwithstanding their powers of locomotion, they often remain within a particular compass, though the plants, and all other circumstances in their immediate vicinity, appear equally favourable for their habitation.

Though insects are distributed in certain limited groups, yet most of the families have representatives in all the great regions of the globe, and some identical species are inhabitants of countries far from one another. The *venussi cardui* live in all the four quarters of the globe and in Australia; and one, which never could have been conveyed by man, is native in southern Europe, the coast of Barbary, and Chili. It is evident from these circumstances that not only each group, but also each particular species, must have been originally created in the places they now inhabit.

Mountain-chains are a complete barrier to insects, even more so than rivers: not only lofty mountains like the Andes divide the kinds, but they are even different on the two sides of the Col de Tende in the Alps. Each soil has kinds peculiar to itself, whether dry or moist, cultivated or wild, meadow or forest. Stagnant water and marshes are generally full of them; some live in water, some run on its surface, and every water-plant affords food and shelter to many different kinds. The east wind seems to have considerable effect in bringing the insect or in developing the eggs of certain species; for example, the aphid, known as the blight in our country, lodges in myriads on plants, and shrivels up their leaves after a continued east wind.

Temperature, by its influence on vegetation, has an indirect effect on the insects that are to feed upon plants, and extremes of heat and cold have more influence on their locality than the mean annual temperature. Thus in the polar regions the musquito tribes are more numerous and more annoying than in temperate countries, because they pass their early stages of existence in water, which shelters them, and the short but hot summer is genial to their brief span of life.

In some instances height corresponds with latitude. The *parnassus apollo*, a butterfly native in the plains of Sweden, is also found in the Alps, the Pyrenees, and even on the Himalaya. Some insects require several years to arrive at



their perfect state. They lie buried in the ground in the form of grubs; the cockchafer comes to maturity in three years, and some American species require a much longer time.

Insects do not attain their perfect state till the plants they are to feed upon are ready for them. Hence in cold and temperate climates their appearance is simultaneous with vegetation; and as the rainy and dry seasons within the tropics correspond to our winter and summer, insects appear there after the rains and vanish in the heat: the rains, if too violent, destroy them; and in countries where that occurs, there are two periods in the year in which they are most abundant, one before and one after the rains. It is also observed in Europe that insects decrease in the heat of summer and become more numerous in autumn: the heat is thought to throw some into a state of torpor, but the greater number perish.

It is not known that any insect depends entirely upon only one species of plant for its existence, or whether it may not have recourse to congeners should its habitual plant perish. When particular species of plants of the same family occur in places widely apart, insects of the same genus will be found on them, so that the existence of the plant may often be inferred from that of the insect, and in several instances the converse.

When a plant is taken from one country to another in which it has no congeners, it is not attacked by the insects of the country: thus our cabbages and carrots in Cayenne are not injured by the insects of that country, and the tulip-tree and other magnolias are not molested by our insects; but if a plant has congeners in its new country, the inhabitants will soon find their way to the stranger.

The common fly is one of the most universal of insects, yet it was unknown in some of the South Sea Islands till it was carried there by ships from Europe, and it has now become a plague.

The musquito and culex are spread over the world more generally than any other tribe: it is the torment of men and animals from the poles to the equator by night and by day: the species are numerous and their location partial. In the Arctic regions the culex pipiens, which passes two-thirds of its existence in water, swarms in summer in myriads: the



lake Myvatr, in Iceland, has its name from the legions of these tormentors that cover its surface. They are less numerous in middle Europe, though one species of musquito, the *simulia columbaschensis*, which is very small, appears in such clouds in parts of Hungary, especially the bannat of Temeswar, that it is not possible to breathe without swallowing many: even cattle and children have died from them. In Lapland there is a plague of the same kind. Of all places on earth the Orinoco and other great rivers of tropical America are the most obnoxious to this plague. The account given by Baron Humboldt is really fearful: at no season of the year, at no hour of the day or night, can rest be found; whole districts in the Upper Orinoco are deserted on account of these insects. New species follow one another with such precision, that the time of day or night may be known accurately from their humming noise, and from the different sensations of the pain which the different poisons produce. The only respite is the interval of a few minutes between the departure of one gang and the arrival of their successors, for the species do not mix. On some parts of the Orinoco the air is one dense cloud of poisonous insects to the height of 20 feet. It is singular that they do not infest rivers that have black water, and each white stream is peopled with its own kinds; though ravenous for blood, they can live without it, as they are found where no animals exist.

In Brazil the quantity of insects is so great in the woods, that their noise is heard in a ship at anchor some distance from the shore.

Various genera of butterflies and moths are very limited in their habitations, others are dispersed over the world, but the species are almost always different. Bees and wasps are equally universal, yet each country has its own. The common honey-bee is the only European insect directly useful to man; it was introduced into North America not many years ago, and is now spread over the continent. European bees, of which there are many species, generally have stings; the Australian bee, like a black fly, is without a sting; and in Brazil there are 30 species of stingless bees.

Fire-flies are mostly tropical, yet there are four species in Europe; in South America there are three species, and so brilliant that their pale green light is seen at the distance of 200 paces.



The silkworm comes from China, and the cochineal insect is a native of South and Central America: there are many species of it in other countries. The *coccus lacca* is Indian; the *coccus ilicis* lives in Italy, and there is one in Poland, but neither of these have been cultivated.

Scorpions under various forms are in all warm climates; 24 species are peculiar to Europe, but they are small in comparison with those in tropical countries: one in Brazil is six inches long. As in musquitoes, the poison of the same species is more active in some situations than in others. At Cumana the sting of the scorpion is little feared, while that of the same species in Carthagera causes loss of speech for many days.

Ants are universally distributed, but of different kinds: they are so destructive in South America, that Baron Humboldt says there is not a manuscript in that country a hundred years old. Near great rivers they build their nests above the line of the annual inundations.

Spiders abound more in Europe than elsewhere; of 900 known kinds, each country has its own, varying in size, colour, and habits, from the huge bird-catching spider of South America, to the almost invisible European gossamer floating in the air on its silvery thread. Many of this ferocious family are aquatic; and spiders, with some other insects, are said to be the first inhabitants of new islands.

The migration of insects is one of the most curious circumstances relating to them: they sometimes appear in great flights in places where they never were seen before, and they continue their course with perseverance which nothing can check. This has been observed in the migration of crawling insects: caterpillars have attempted to cross a stream. Countries near deserts are most exposed to the invasion of locusts which deposit their eggs in the sand, and when the young are hatched by the sun's heat, they emerge from the ground without wings; but as soon as they attain maturity, they obey the impulse of the first wind and fly, under the guidance of a leader, in a mass, whose front keeps a straight line, so dense that it forms a cloud in the air, and the sound of their wings is like the murmur of the distant sea. They take immense flights, crossing the Mozambique channel from Africa to Madagascar, which is 120 miles broad; they come from Barbary to Italy, and a few have been seen in Scotland.



Even the wandering tribes of locusts differ in species in different deserts, following the universal law of organized nature. Mr. Ehrenberg has discovered a new world of creatures in the Infusoria, so minute that they are invisible to the naked eye. He found them in fog, rain, and snow, in the ocean, in stagnant water, in animal and vegetable juices, in the dusty air that sometimes falls on the ocean; and he detected 18 species 20 feet below the surface of the ground, in peat earth, which was full of microscopic live animals; they exist in ice, and are not killed by boiling water. This lowest order of animal life is much more abundant than any other, and new species are found every day. Magnified, some of them seem to consist of a transparent vesicle, and some have a tail: they move with great alacrity, and show intelligence by avoiding obstacles in their course: others have siliceous shells. Language, and even imagination, fails in the attempt to describe the inconceivable myriads of these invisible inhabitants of the ocean, the air, and the earth: they no doubt become the prey of larger creatures, and perhaps blood-sucking insects may have recourse to them when other prey is wanting.

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## CHAPTER XXVII.

### DISTRIBUTION OF FISHES, AND OF THE MARINE MAMMALIA, PHOCÆ, DOLPHINS, AND WHALES.

BEFORE Sir James Ross's voyage to the Antarctic regions, the profound and dark abysses of the ocean were supposed to be entirely destitute of animal life; now it may be presumed that no part of it is uninhabited, since during that expedition live creatures were fished up from a depth of 6000 feet. But as most of the larger fish usually frequent shallow water near the coasts, deep seas must form barriers as impassable to the greater number of them as mountains do to land animals. The polar, the equatorial ocean, and the inland seas, have each their own particular inhabitants; almost all the species and many of the genera of the marine creation are different in the two hemispheres, and even in each particular sea; and under similar circumstances the species are



for the most part representative, not the same. Identity of species, however, does occur, even at the two extremities of the globe, for living animals were brought up from the profound depths of the Antarctic Ocean which Sir James Ross recognized to be the very same species which he had often met with in the Arctic seas. "The only way they could have got from the one pole to the other must have been through the tropics; but the temperature of the sea in these regions is such that they could not exist in it unless at a depth of nearly 2000 fathoms. At that depth they might pass from the Arctic to the Antarctic Ocean without a variation of 5 degrees of temperature; whilst any land animal, at the most favourable season, must experience a difference of 50 degrees, and if in winter, no less than 150 degrees of Fahrenheit's thermometer;"—a strong presumption that marine creatures can exist at the depth and under the enormous pressure of 12,000 feet of water.

The form and nature of the coasts have great influence on the distribution of fishes; when they are uniformly of the same geological structure, so as to afford the same food and shelter, the fish are the same, or similar.

The ocean, the most varied and most wonderful part of the creation, absolutely teems with life: "things innumerable, both great and small, are there." The forms are not to be numbered even of those within our reach; yet, numerous as they are, few have been found exempt from the laws of geographical distribution.

The discoloured portions of the ocean generally owe the tints they assume to myriads of insects. In the Arctic seas, where the water is pure transparent ultramarine colour, parts of 20 or 30 square miles, 1500 feet deep, are green and turbid from the quantity of minute animalcules. Captain Scoresby calculated that it would require 80,000 persons, working unceasingly from the creation of man to the present day, to count the number of insects contained in two miles of the green water. What then must be the amount of animal life in the polar regions, where one-fourth part of the Greenland sea, for 10 degrees of latitude, consists of that water. These animalcules are of the medusa tribe, mixed with others that are moniliform. Some medusæ are very large, floating like jelly; and although apparently carried at random by the waves, each species has its definite location, and even loco-



motion. One species comes in spring from the Greenland seas to the coast of Holland ; and Baron Humboldt met with an immense shoal of them in the Atlantic, migrating at a rapid rate.

Dr. Pœppig mentions a stratum of red water near Cape Pelaris, 24 miles long and 7 broad, which seen from the mast-head appeared dark-red, but on proceeding it became a brilliant purple, and the wake of the vessel was rose-colour. The water was perfectly transparent, but small red dots could be discerned moving in spiral lines. The vermilion sea off California is no doubt owing to a similar cause, as Mr. Darwin found red and chocolate-coloured water on the coast of Chili over spaces of several square miles full of microscopic animalcules, darting about in every direction, and sometimes exploding. Infusoria are not confined to water; the bottom of the sea swarms with them. Siliceous-coated infusoria are found in the mud of the coral islands under the equator ; and 68 species were discovered in the mud in Erebus Bay, near the Antarctic pole. These minute forms of organized being, invisible to the naked eye, are intensely and extensively developed in both of the polar oceans, and serve for food to the higher orders of fish in latitudes beyond the limits of vegetation. Some are peculiar to each of the polar seas, some are common to both, and a few are distributed extensively throughout the ocean.

The enormous prodigality of animal life supplies the place of vegetation, so scanty in the ocean in comparison with that which clothes the land, and which probably would be insufficient for the supply of the marine creation, were the deficiency not made up by the superabundant land vegetation, and insects carried to the sea by rivers. The fish that live on sea-weed must bear a smaller proportion to those that are predacious, than the herbivorous land animals do to the carnivorous. Fish certainly are most voracious : none are without their enemies ; they prey and are preyed upon ; and there are two which devour even the live coral, hard as its coating is ; nor does the coat of mail of shell-fish protect them. Whatever the proportion may be which predatory fish bear to herbivorous, the quantity of both must be enormous, for, besides the infusoria, the great forests of fuci and sea-weed are everywhere a mass of infinitely varied forms of being, either parasitical, feeding on them, seeking shelter among them, or in pursuit of others.



The observations of Professor E. Forbes in the Egean Sea show that depth has great influence in the geographical distribution of marine animals. From the surface to the depth of 230 fathoms there are eight distinct regions in that sea, each of which has its own vegetation and inhabitants. The number of shell-fish and other marine animals is greater specifically and individually between the surface and the depth of two fathoms than in all the regions below taken together, and both decrease downwards to the depth of 105 fathoms; between which and the depth of 230 only eight shell-fish were found; and animal life ceases in that part of the Mediterranean at 300 fathoms. The changes in the different zones are not abrupt; some of the creatures of an under region always appear before those of the region above vanish; and although there are a few species the same in some of the eight zones, only two are common to all. Those near the surface have forms and colours belonging to the inhabitants of southern latitudes, while those lower down are analogous to the animals of northern seas; so that in the sea depth corresponds with latitude, as height does on land. Moreover, the extent of the geographical distribution of any species is proportional to the depth at which it lives; consequently, those living near the surface are less widely dispersed than those inhabiting deep water. Professor Forbes also discovered several shell-fish living in the Mediterranean that have hitherto only been known as fossils of the tertiary strata; and also that the species least abundant as fossils are most numerous alive, and the converse; hence the former are near their maximum, while the latter are approaching to extinction. These very important experiments, it is true, were confined to the Mediterranean; but analogous results have been obtained in the Bay of Biscay and in the British seas. There are four zones of depth in our seas, each of which has its own inhabitants, consisting of shell-fish, crustaceæ, corallines, and other marine creatures. The first zone lies between high and low-water marks, consequently it is shallow in some places and 30 feet deep in others. In all parts of the northern hemisphere it presents the same phenomena; but the animals vary with the nature of the coast, according as it is of rock, gravel, sand, or mud. In the British seas the animals of this littoral or coast zone are distributed in three groups that differ decidedly from one another,



though many are common to all. One occupies the seas on the southern shores of our islands and both channels ; a middle group has its centre in the Irish seas ; and the third is confined to the Scottish seas, and the adjacent coasts of England and Ireland. The second zone extends from the low-water mark to a depth below it of from 7 to 15 fathoms, and is crowded with animals living on and among the sea-weeds, as radiated animals, shell-fish, and many zoophytes. In the third zone, which is below that of vegetable life, marine animals are more numerous and of greater variety than in any other. It is particularly distinguished by arborescent creatures, that seem to take the place of plants, carnivorous mollusca, together with large and peculiar radiata. It ranges from the depth of 15 to 50 fathoms. The last zone is the region of stronger corals, peculiar mollusca, and of others that only inhabit deep water. This zone extends to the depth of 100 fathoms or more.

Except in the Antarctic seas, the superior zone of shell-fish is the only one of which any thing is known in the great oceans, which have numerous special provinces ; but, according to Mr. Lyell, nearly all the species of molluscous animals in the seas of the two temperate zones are distinct, yet the whole species in one bears a strong analogy to that in the other ; both differ widely from those in the tropical and arctic oceans ; and, under the same latitude, species vary with the longitude. The east and west coasts of tropical America have only one shell-fish in common ; and those of both differ from the shell-fish in the islands of the Pacific and the Gallipagos Archipelago, which forms a distinct region. Notwithstanding the many definite marine provinces, the same species are occasionally found in regions widely separated. A few of the shell-fish of the Gallipagos Archipelago are the same with those of the Philippine Islands, though so far apart. The east coast of America, which is poor in shell-fish, has a considerable number in common with the coasts of Europe.

The larger and more active inhabitants of the waters obey the same laws with the rest of the creation, though the provinces are in some instances very extensive. Dr. Richardson observes, that there is one vast province in the Pacific, extending  $42^{\circ}$  on each side of the equator, between the meridians including Australia, New Zealand, the Malay



Archipelago, China, and Japan, in which the genera are the same ; but at its extremities the Arctic and Antarctic genera are mingled with the tropical forms. Very many species of the Red Sea and eastern coast of Africa range to the Indian and China seas, those of North Australia, and all Oceanica ; the continuous chains of islands being favourable to their dispersion. Few of the Pacific fish enter the Atlantic ; and, from the depth and want of islands in the latter, the great bulk of species are different on its different sides. Many families are common to the colder seas in both hemispheres ; but the genera are mostly different, the species always.

The British Islands lie between two great provinces of fishes—one to the south, the other to the north—from each of which we have occasional visitors. The centre of the first is on the coasts of the Spanish peninsula, extending into the Mediterranean. That on the north has its centre about the Zetland Islands ; but the group peculiarly British, and found nowhere else, has its focus in the Irish Sea. It is, however, mixed with fish from the seas bounding the western shores of Central Europe, which form a distinct group.

Prince Canino has shown that there are 853 species of European fish, of which 210 live in fresh water, 643 are marine, and 60 of these go up rivers to spawn. 444 of the marine fish inhabit the Mediterranean, 216 are British, and 171 are peculiar to the Scandinavian seas ; so that the Mediterranean is richest in variety of species. In it there are peculiar sharks, sword-fish, dolphins, archovies, and six species of tunny, one of the largest of edible fish, for which fisheries are established in Elba, the Straits of Messina, and the Adriatic. Four of the species are found nowhere else but in the Mediterranean. Rays of numerous species are particularly characteristic of the Mediterranean, especially the two torpedos, which have the power of giving an electric shock, and even the electric spark. The Mediterranean has two or three American species ; 41 fish in common with Madeira, one in common with the Red Sea, and a very few seem to be Indian. Some of these fish must have entered the Mediterranean before it was separated from the Red Sea by the Isthmus of Suez ; but geological changes have had very great influence on the distribution of fishes everywhere. Taking salt and fresh-water fish together, there are 100 species common to Italy and Britain ; and although the com-



munication with the Black Sea is so direct, there are only 27 fish common to it and the Mediterranean ; but the Black Sea forms a district by itself, having its own peculiar fish ; and those in the Caspian Sea differ entirely from those in every other part of the globe. The island of Madeira, solitary amid a great expanse of ocean, has many species. They amount in number to half of those in Britain ; and nearly as many are common to Britain and Madeira as to that island and the Mediterranean ; so that many of our fish have a wide range in the Atlantic. The Mediterranean certainly surpasses the British and Scandinavian seas in variety, though it is far inferior to either in the quantity or quality of useful fish. Cod, turbot, haddock, tusk, ling, herring, and many more, are better in northern seas than elsewhere, and several exist there only.

Whales and sharks like deep water. Different species of sharks are in all tropical and temperate seas ; and, although always dangerous, they are more ferocious in some places than others, even where of the same species.

The greater number of fish used by man as food frequent shoal water. The coast of Holland, our own shores, and other parts of the North Sea, where the water is shallow, teem with a never-ending supply of excellent fish, of many kinds.

Vast numbers are gregarious and migratory. Cod arrive in the shallow parts of the coast of Norway in February, in shoals many yards deep, and so closely crowded together that the sounding-lead can hardly pass between them : 16,000,000 have been caught in one place in a few weeks. In April they return to the ocean. Herrings come in astonishing quantities in winter ; and lobsters are so plentiful among the rocks in Norway, that many hundred thousands are caught every year.

The principal cod fisheries are on the banks of Newfoundland and the Dogger-bank. They, like all animals, frequent the places to which they have been accustomed. Herrings come to the same places for a series of years, and then desert them, perhaps from having exhausted the food. Pilchards, mackerel, and many others, may be mentioned among the gregarious and migratory fish.

Most lakes have fish of peculiar species, as the lake Baikal. In the North American lakes there is a thick-scaled-fish, analo-



gousto those of the early geological eras; and the gillaroo trout, which is remarkable in having a gizzard, is found in Ireland only. Forty-four fish inhabit the British lakes and rivers, and fifty those of Scandinavia, of the very best kinds. The fresh-water fish of northern climates are better than those of the southern, as salmon of various species.

Each tropical river has its own species of fish; and sea-fish, in immense quantities, frequent the estuaries of rivers everywhere. The mouth of the Mississippi is full of fish; and the quantity at the mouth of the Don, in the Sea of Azof, is prodigious.

There are some singular analogies between the inhabitants of the sea and those of the land. Many of the medusæ, two corallines, the sea-stag, and some others, sting. A cuttle-fish, at the Cape de Verde islands, changes colour like the cameleon, assuming the tint of the ground under it. Herrings, pilchards, and many other fish, as well as sea insects, are luminous. The medusa tribe, the species of which are numerous, have the faculty of shedding light in the highest degree. In warm climates, especially, the sea seems to be on fire, and the wake of a ship is like a vivid flame. Probably fish that go below the depths to which the light of the sun penetrates are endowed with this faculty; and shoals of luminous insects have been seen at a considerable depth below the surface of the water. The glow-worm, some beetles, and fire-flies, shine with the same pale green light. But among the terrestrial inhabitants there is nothing analogous to the property of the *gymnotus electricus* of South America, the trembler, or *silurius electricus*, of the African rivers, and the different species of the torpedo of the Mediterranean, besides many others, mostly of the ray kind, in various parts of the world, which possess the faculty of giving the electric shock.

The marine mammalia form several families, all of which suckle their young. Fish require air like other animals, and obtain it from the water by means of their gills; but as the whale family are not fish, they are obliged to come to the surface of the sea to breathe, which they do through nostrils.\* Fat pervades every part of their body and bones, which makes them buoyant, and enables them to float with-

\* Narrative of a Whaling Voyage, round the World, by F. D. Bennett, Esq.



out fatigue or effort ; and their blood is said to be warmer than that of land animals, so that they can bear the most intense cold.

The first family of the whale tribe consists of herbivorous phocæ, as lamantins and dugons, and of predatory phocæ, as seals, and the morse or walrus, all of which have teeth and are amphibious, and some of the numerous species are found in every sea and in every latitude, but the herbivorous phocæ are mostly intertropical. Lamantins are of various sizes and kinds ; the species which frequents the Antilles, the Orinoco, and Amazons, and other rivers in the warmer parts of America, generally known as the sea-cow, is about 20 feet long, and has a round body, not unlike a sack of wine. It browses in herds on the herbage at the bottom and on the banks of streams, and when attacked the mother defends her young at the sacrifice of her own life, and the cub follows the dead body to the shore, so both fall an easy prey to the hunters. The dugon is not so round as the lamantin, and has a bristled snout ; different species feed in flocks on the weeds at the bottom of shallow parts of the Indian Ocean, the Indian Archipelago, the coasts of Africa, New Holland, and the Red Sea, and never enter fresh water. They are so harmless and tame that they allow themselves to be handled, and they sit upright when they suckle their young, which has given rise to the fable of the Mermaid. This animal sacrifices her life for her young like the lamantin, and is the type of maternal affection among the Malays. The *manatus septentrionalis* is the only herbivorous seal that is found in the Arctic Ocean ; it frequents the Spitzbergen seas, but is very rare.

The favourite haunts of the predatory seals are the polar oceans and desert islands in high latitudes, where they bask in hundreds on the sunny shores during the brief summer of these inhospitable regions, and become an easy prey to man, who has nearly extirpated the race in many places. Six or seven species of seals are natives of Iceland, and two or three of Greenland. The common seal is six or seven feet long, with a face like that of a dog, and a large intelligent eye. It is easily tamed, and in the Orkney Islands it is so much domesticated that it follows its master, and helps him to catch fish. This seal migrates in herds from Greenland twice in the year, and returns again to its former haunts ;



they probably come to the coasts of Europe and the British Islands at the time of their migrations, but the *phoca vetulina* is a constant inhabitant of our shores. Some of the seal tribe have a very wide range, as the fur species, *arctocephalus ursinus*, of the Falkland Islands, which at one time frequented the southern coasts of New Holland in multitudes, but they and three other species have now become scarce from the indiscriminate slaughter of old and young. Sir James Ross found some of the islands in the Antarctic seas overrun with the sea elephant *morenga elephantina*, and they captured a new species of seal without ears. The walrus or morse, a grim-looking creature, with tusks two feet long bent downwards, and its face covered with transparent bristles, has a body like that of a seal, 20 feet long, with a coat of short grey or yellow hair. It sleeps on the floating ice, feeds on sea-weeds and marine animals, and never leaves the Arctic seas.

The second family of marine mammalia consists of spouting whales of predatory habits; they live on fish, and consequently have teeth, such as porpoises, dolphins of many kinds, and spermaceti whales or cachelots; these have spouting nostrils in the upper part of the head. The common porpoise is seen spouting and tumbling on the surface of all the seas of Europe, shoals of them go in pursuit of herrings and mackerel, and even swim up the rivers in chase of salmon. They have more the form of fish than the seal tribe, and have a dorsal fin. The common dolphins, so remarkable for voracity and for the swiftness of their motions, which is owing to the symmetry of their form and the width of their tail, are seen in almost every latitude and sea, but probably of different species. The white dolphin, eaten by the Icelanders, is 18 feet long, and migrates from the Atlantic to Greenland in the end of November. The grampus, *delphinus orca*, possibly the same with the killer of the South Sea whalers, is a fierce voracious fish, often 20 feet long, which roams in numerous shoals, preying upon the larger fish, and even attacking the whale. The grind or black dolphin has been known to run ashore in hundreds in the bays of Feroe, Orkney, and Zetland. This seems to be the same or nearly allied to the black fish, which was met with in vast numbers by Sir James Ross in the Antarctic seas: they had so little fear, that they darted below the ship



on one side and came up at the other. The right white porpoise, *delphinus peronii*, of the southern whalers, is a rare and elegant species of dolphin which chiefly inhabits the high southern latitudes, but has been seen at the equator in the Pacific. They are about six feet long, the hinder part of the head, the back, and the flukes of their tail are black, and all the rest of the purest white. The narwhal or sea unicorn, *monodon monoceros*, has no teeth, but a tusk of fine ivory wreathed with a spiral groove extending eight or ten feet straight from the head; in general there is only one tusk, but there are always the rudiments of another, and occasionally both grow to an equal length. The old narwhals are white with blackish spots, the young are dark-coloured. This singular creature, which is about 16 feet long without the tusk, swims with great swiftness. Mr. Scoresby has seen 15 or 20 at a time playing round his ship in the Arctic seas, and crossing their long tusks in all directions as if they were fencing; they are found in all parts of the Northern Ocean.

The spermaceti whale, the cachelot or *physeter macrocephalus*, belonging to the family of the predaceous spouters, is one of the most formidable inhabitants of the deep. Its average size is 60 feet long and 40 feet in circumference; its head, equal to a third of its length, is extremely thick and blunt in front, with a throat wide enough to swallow a man. The proportionally small swimming paws or pectoral fins are at a short distance behind the head, and the tail, which is a horizontal triangle six or seven feet long, and 19 feet wide, with a notch between the flukes, is the chief organ of progressive motion and defence. It has a hump of fat on its back, is of a dark colour, but with a very smooth clean skin. These sperm whales have one nostril on the top of their head, through which they throw in breathing a continued succession of jets like smoke, at intervals of 15 or 20 minutes, after which they toss their tails high in the air and go head foremost to vast depths, where they remain for an hour or an hour and a half, and then return again to the surface to breathe. The jet or spout is from six to eight feet high, and consists of air expired by the whale, condensed vapour, and particles of water. This whale has sperm-oil and spermaceti in every part of its body, but the latter is chiefly in a vast reservoir in its head, which makes it very buoyant, and am-



bergris is sometimes found in the inside of the body, supposed to be from disease. These huge monsters, occasionally 75 feet long, go in great herds of 500 or 600, or schools, as the whalers call them. Females with their young, and two or three old males, generally form one company, and the young males another, while the old males feed and hunt singly. The sperm whales swim gracefully and equally, with their head above the water; but when a troop of them play on the surface of the water, some of these uncouth and gigantic creatures leap with the agility of a salmon several feet into the air, and fall down again heavily with a tremendous crash and noise like a cannon, driving the water up in lofty columns capped with foam. The fishery of the sperm whale is attended with great danger; not only the wounded animals, but its companions who come to its aid, sometimes fight desperately, killing the whalers and tossing them into the air with a sweep of their tremendous tails, or biting a boat in two. In 1820 the American whaler *Essex* was wrecked in the Pacific by a sperm whale; it first gave the ship so severe a blow that it broke off part of the keel, then retreating to a distance, it rushed furiously, and with its enormous head beat in a portion of the planks, and the people had just time to save themselves in the boats when the vessel filled. They often lie and listen when suspicious of mischief. No part of the aqueous globe, except the Arctic seas, is free from their visits; they have been seen in the Mediterranean, the British Channel, and even the Thames, but their chief resort is the deepest parts of the warmer seas within or near the tropics, and in the Antarctic Ocean, where they feed on floating shell-fish and the sepia or cuttle-fish.

The third and last family of marine mammalia are whalebone whales, such as the Greenland whales and rorquals. Instead of teeth, the jaws of these animals are furnished with plates and filaments of whalebone, which are movable, and are adapted to retain, as in a net, the medusæ and other small marine animals that are the food of these colossal inhabitants of the deep. The common Greenland species, *balæna mysticetus*, was formerly much more numerous, but it is now chiefly confined to the very high northern latitudes; however should it be the same with the whale found in such multitudes in shallow water on the coasts of the Pacific and in the Antarctic Ocean by Sir James Ross, it must have a very wide



range, but it is more probable that each pole has its own species. The Greenland whale is from 65 to 70 feet long, but they are so much persecuted that they probably never live long enough to come to their full size. The head is very large, but the opening of the throat is so narrow that it can only swallow small animals. It has no dorsal fin: the swimming paws are about nine feet long, and the flat tail is half-moon shaped and notched in the middle. It has two spouts or nostrils, through which it throws jets like puffs of smoke some yards high. It only remains two or three minutes on the surface to breathe, and then goes under water for five or six. The back and tail are velvet-black, shaded in some places into grey, the rest is white: some are piebald. The capture of this whale is often attended with much cruelty, from their affection for their young; indeed the custom of killing the calf in order to capture the mother has ruined the fishery in several places, especially in New Zealand, where there were eight species of whales in vast abundance.

Rorquals are also whalebone whales, differing somewhat in form from the common whale. One species is from 80 to 100 feet long, the largest of marine animals. The bottle-nosed whale, a smaller species, was exceedingly numerous in the Arctic seas; in the year 1809, 1100 were stranded in Huelford in Iceland. This whale travels to lower latitudes in pursuit of herrings and other fish. It had been caught on the coast of Norway as early as the year 890, and probably long before. The first northern navigators were not attracted by the whale as an object of commerce, but stumbled upon it in their search for a north-west passage to the Pacific. The hump-backed whale, *balæna gibbosa*, a rorqual 30 or 40 feet long, is met with in small herds in the intertropical and southern regions of the Pacific and Atlantic: it is seldom molested by the whalers, and is very dangerous for boats, from the habit it has of leaping and rising suddenly to the surface. None of the senses of the whale tribe are very acute; the whalebone whales alone have the sense of smelling, and although the sperm whale is immediately aware of a companion being harpooned at a very great distance, they do not hear well in air, and none have voice.\*

\* Captain Scoresby's Arctic Voyages.



## CHAPTER XXVIII.

## DISTRIBUTION OF REPTILES—FROGS AND TOADS—SNAKES, SAURIANS, AND TORTOISES.

REPTILES, more than any other class of animals, show the partial distribution of animated beings, because, being unable to travel to any great distance, they have remained in the places wherein they were originally stationed; and as they inhabit deserts, forests, and uncultivated ground, they have not been disturbed by man, who has only destroyed some individuals, but has not diminished the number of species, which is probably the same as ever it was. Few of the mammalia hibernate, or fall into a torpid state in winter, except the bear, marmot, bats, and some others. Their fat supplies the carbon consumed by the oxygen during their feeble and imperceptible respiration, and is wasted by the time the warm weather returns, which rouses them from their lethargy, thin and extenuated. But reptiles, being colder blooded, bury themselves in the ground, and hibernate during the winter in cold and temperate climates. In hot countries, they fall into a state of torpor during the dry season, so that they have no occasion to wander either on account of temperature or want of sustenance; and the few that do migrate in quest of food, always return to their old haunts. As the blood of reptiles receives only a small part of the oxygen they inhale, little heat and strength are generated; consequently they are cold-blooded, and for the most part sluggish in their motions, which, however, are more varied than in quadrupeds; but as some reptiles, as tortoises and lizards, breathe more frequently than others, there are consequently great differences in their energy and sensibility. There are four distinct classes of reptiles—toads and frogs, serpents, lizards, and tortoises. These partake of both terrestrial and aquatic forms, and many are amphibious: they all increase in numbers towards the equator, and few live in cold climates.

The toad and frog class approaches nearest to the nature of fishes, and forms a link between land and water animals.



As tadpoles they have tails and no feet, but when full grown, they generally acquire feet and lose their tails. Besides, in that early stage they are aquatic, and breathe by gills, like fishes; but in a state of maturity they breathe by lungs, like quadrupeds, though some of the families always retain their gills and tails, and some never acquire feet. These animals have the power of retarding and accelerating their respiration without stopping the circulation of their blood, so that they can resist heat and cold to a certain degree—a power most remarkable in the salamander, which forms part of this class, so varied in appearance and nature. Some, as toads and frogs, imbibe a quantity of water, which is evaporated through their skin more or less quickly. This keeps them at the temperature of the medium they live in, and the air they inhale through the skin is as necessary to their existence as that which they breathe.

The group of toads and frogs consists of four families, which have four feet, but neither necks nor tails; namely, frogs, hylas or rainettes, toads, and pipæ. Frogs, which are amphibious, have no nails on their toes, and their hind legs are webbed, consequently fitted for swimming, which they do by leaps. There are 16 genera, and above 50 species, so that they are more numerous and more varied than any other reptile. Of the hyla, rainette, or tree-frog, there are 60 species, all of the most vivid and brilliant tints, and several colours are frequently united on the same animal. They spend most of their lives on high trees, and their webbed feet have little cushions at the points of their toes, by means of which they can squeeze out the air from under their feet, and, by the pressure of the atmosphere, they adhere firmly to the under side of the smoothest leaf, exactly on the same principle by which flies walk on the ceiling of a room. The bufo, or toad, is the ugliest of the race; many are hideous, with swollen bodies and obtuse toes. They do not go into water, but frequent marshy, damp places, and only crawl, whereas the frog and hyla leap. They are much fewer than either of the other two families; only thirty species are known. The pipæ are also toads of a still more disgusting form, and are distinguished from their congeners by having no tongue. There are only two species known. All these reptiles have voices, which are exceedingly varied; they croak in concert, following a leader, and when he is tired another takes his



place. One of the North American frogs croaks in bands ; one band begins, another answers, and a third replies, till the noise is heard at a great distance ; a pause then takes place, after which the croaking is renewed. Mr. Darwin mentions a little musical hyla at Rio de Janeiro, which croaks a kind of harmony in different notes.

Toads and frogs are found in almost all parts of the earth, though very unequally and partially distributed. America has more than all the other countries taken together, and Europe the fewest. Six species of frogs, one rainette, and two toads, are European ; and all, except four of the frogs, are also found in Asia and Africa.

The law of circumscribed distribution is strongly marked in Asia ; for of ten species of frogs peculiar to that continent, three only are in the mainland, two are confined to Japan ; and of the five that are Javanese, one is also common to Amboina, and the other four to Bengal. The eight species of rainettes, or tree-frogs, are still more limited in their domicile : five of them are in Java only, and one in Japan. There are nine species of toad peculiar to Asia.

None of these reptiles exist in the Galapagos Archipelago, nor in any of the innumerable islands in Oceanica, and there are very few in Australia, but all peculiar. In Africa there are eight species of frogs, two or three of rainettes, and two of toads. One of the two species of pipas, more horrid in appearance than any toad, is very common at the Cape of Good Hope, and there only.

The great extent of marshes, rivers, and forests, together with the heat of the climate, make America the very home of reptiles of this kind, and there they grow to a greater size than anywhere else : 23 species of frog, 27 species of tree-frog or rainette, and 21 of toads, are indigenous in that continent, not one of which is the same with any of those in the old world ; and most of those in South America are different from those in the northern part of the continent, though they are sometimes replaced by analogous kinds. All these reptiles have abodes, with fixed demarcations, often of small extent. The pipa, or toad of Surinam, is the most horrid of the tribe ; the bufo agua, of Brazil, 10 or 12 inches long, and the rana pipiens, of Carolina, are the largest.

The second family of this class of reptiles have tails and



feet, as the salamanders, which are very like lizards, with a long round tail, and four feet. Some are terrestrial, and some are aquatic : the latter are known as tritons. Both are in Europe, but the greater number are American ; and the sirens are peculiar to the marshes and rice-grounds of Carolina. They are very like eels with two feet. The *proteus anguinus* is similar, but it has four little feet and a flat tail, and has been found nowhere but in the dark subterraneous caverns in Carniola.

The third family of this class of reptiles is the *cæciliæ*, of which there are only eight species, all inhabitants of the warm parts of Asia, Africa, and America. They have a cylindrical body, without feet or neck, and move exactly as the serpent, so they seem to form the link between these reptiles and the class of frogs and toads.

There are serpents in all hot and temperate countries, but they abound most in intertropical regions ; and wherever snakes exist, there also are some of the venomous kinds, but they are fewer specifically and individually than is generally supposed. Of 263 species, only 57 are venomous, or about one in five, although that proportion is not everywhere the same. In sterile, open countries, the proportion of venomous snakes is greater than in those that are covered with vegetation. Thus, in New Holland, seven out of ten species are poisonous ; and in Africa, one of every two or three individuals is noxious. In general, however, the number of harmless individuals is 20 times as great as the number of the poisonous.

The three great families of venomous serpents are the colubriform or adder-shaped snakes, sea-serpents, and the triangular-headed snakes.

The adder-formed snakes are divided into three genera, the elaps tribe, which are slender like a cord, with a small head and of brilliant colours. There are four species in South America, of which two are confined to Guiana, and one to Surinam, while the other is found everywhere from Brazil to Carolina. There is only one in Africa, three in Australia, and the rest are in limited districts in tropical Asia, especially in Sumatra and Java ; and an entire genus is found only in India, and the islands of Ceylon and Java. The hooded snakes are the best known of this family, especially the spectacled or dancing snake of the Indian jugglers,



which is common everywhere from Malabar to Sumatra, and two other species are only in Sumatra and Java. The three or four African species are chiefly at the Cape of Good Hope and on the Gold Coast; but the most celebrated is that generally known as the Egyptian asp, which has been tamed by magicians of ancient and modern times, and is frequently figured in Egyptian monuments; it derives some of its celebrity from Cleopatra's death. Two of the family inhabit New Holland, one of which is spectacled, but of a different species from that in India.

All the seven species of sea-snakes are very venomous, and more ferocious than any other. They frequent the Indian Ocean in shoals from Malabar to the Philippine Islands, but chiefly the Bay of Bengal; they never enter fresh water, nor do they ever land.

The third venomous family consists of the triangular-headed serpents, rattle-snakes, and vipers. The first are of a hideous aspect,—a large head, broad at the base like a heart, a wide mouth, with their hooked poisonous fangs strongly developed. They quietly watch their prey till it is within reach, then dart upon it, and inflict the deadly wound in a moment. There are four species of these formidable snakes in the intertropical parts of South America, and in the warmer parts of North America. One species in the old world is to be met with everywhere, from Ceylon to the Philippine Islands; one is a native in Sumatra, Timor, and Celebes; the rest are narrowly limited in their abode; two are confined to Java alone. Ceylon, Sumatra, Japan, and Tartary, have each a species of these serpents peculiar to itself.

The rattle-snakes are all American—two in the warm districts of North America, and two in the intertropical parts of South America. One of the latter, however, has a hard horn at the end of its tail, instead of a rattle, and sometimes grows to the length of 10 feet, being the longest of the venomous snakes.

Vipers come farther north than any other of the noxious tribe: two are Asiatic, though one is also common to Africa, which, however, has four peculiar to itself: and the only venomous serpents in Europe are three species of viper, one of which is also spread over the neighbouring parts of Asia and Africa. The common viper inhabits all central Europe



and temperate Asia, even to Lake Baikal, in the Altai Mountains: it is also found in England and Sweden, but it does not go farther west than the Seine, nor does it pass the Alps. One which frequents dry soils, in the south-east of Europe, is in Styria, Greece, Dalmatia, and Sicily; and the aspic viper, which lives on rocky ground, inhabits France between the Seine and the Pyrenees, Switzerland, Italy, and Sicily.

There are six families of harmless serpents, consisting of numerous species. Four of the families are terrestrial, their species are very limited in their domicile, the greater number being confined to some of the islands of the Indian Archipelago, Ceylon, or to circumscribed districts in tropical Asia, Africa, and America. Nine or ten species are European, some of which are also found in Asia and Africa.

Tree-serpents of various genera and numerous species live only in the great tropical forests of Asia and America, especially in the latter. They are long and slender, the head for the most part ending in a sharp point, and generally green, though there are some of brighter colours; many of these serpents are fierce, though not venomous; some feed on birds, which they watch hanging by the tail from a bough.

In all temperate and warm countries abounding in lakes and rivers, fresh-water snakes are numerous; some live in the water, but they mostly inhabit the banks near it; they are excellent swimmers, and may be seen crossing lakes in shoals. America is particularly rich in them; there are several in Europe and Asia, but they are rare in Africa, and none have been yet discovered in Australia.

The boa is peculiarly American, though some smaller in size and differing in species are found in Asia. The boa constrictor, generally from 9 to 12 feet long, lives in the great tropical forests of South America, where it watches its prey hanging from the boughs of trees. Two of smaller size have similar habits, and two are aquatic, one of which is sometimes 20 feet long, and another 6 feet; the latter inhabits the rivers from the Amazons to Surinam.

Pythons are the largest snakes of the eastern world; one species, which sometimes grows to the length of 20 feet, is spread from the western coast of Africa, throughout inter-tropical Asia to Java and China. Another, only 14 feet



long, is confined to Malacca and some of the Sunda Islands. Two others are found only in the islands of Timor and Saparua, and one in New Holland. There are only two species of *acrochordi*, which, like boas, and pythons, twist themselves round their victims and crush them to death: one aquatic, peculiar to Java; the other is a land snake, found everywhere through India to New Guinea.

The West Indian Islands have the snakes of North and South America, and some peculiar; the snakes of central America are little known.

Saurians have representatives in every warm and temperate climate. The crocodile, from its size and ferocity, claims the first place. There are three genera of this family, all amphibious, living in rivers: the crocodile, common to the old and new continents; the caiman, or alligator, peculiar to America; and the gavial, which comes nearer to the form of the fossil crocodile than any other, is limited to the Ganges and other great rivers of India. The various species of crocodiles are confined to local habitations: three are Asiatic; two African, one of which is only in Sierra Leone; two are peculiar to Madagascar; and in America there are two species of crocodiles and five of alligators. The American crocodiles inhabit the estuaries of great rivers; the alligator never leaves fresh water.

The alligators of the Mississippi, and of the rivers and marshes of Carolina, are more ferocious than those of South America, attacking men and animals; they only prey in the night; while in the water, they cannot swallow their food, but they drown the animal they have caught, hide it under water till it is putrid, and then bring it to land to eat it. Locality has considerable influence on the nature and habits of these animals; in one spot they are very dangerous, while in another, at no great distance they are cowardly. Alligators are rarely more than 15 feet long, and are seen in great companies basking on the banks of rivers: their cry is like the roar of a bull; in a storm they bellow loudly, and are said to be much afraid of some of the whale family that ascend the great American rivers. The female watches her eggs and her young for months, never losing sight of them; but the male devours many of them when they go into the water. All animals of this class are covered with scales, those of the crocodile family are hard and impenetrable.



Lizards are chiefly distinguished from crocodiles by having a long, thin, forked tongue like that of the viper; by their rapid motions, smaller size; and by some peculiarities of form.

The monitors, which are entirely confined to the old continent, have the tail compressed laterally, which enables them to swim rapidly; and they are furnished with strong sharp teeth. Many species inhabit Africa and India, especially the Indian Archipelago: the terrestrial crocodile of Herodotus is common on the deserts round Egypt; and an aquatic species in the Nile, which devours the crocodile's eggs, is often represented on the ancient Egyptian monuments.

Another group of the monitor family is peculiarly American; some of the species inhabiting the marshes in Guiana are six feet long.

Lizards are very common; more than eight or nine species are European: and the iguanians, which differ from them only in the form of the tongue, are so numerous in genera and species, that it would be in vain to attempt to follow all their ramifications, which are, nevertheless, distributed according to the same laws with other creatures: but the dragons, only found in India, are too singular to be passed over. The dragon is in fact a lizard with wings of skin, which are spread along its sides and attached to its fore and hind feet, like those of the bat, and though they do not enable it to fly, they act like a parachute when the animal leaps from bough to bough in pursuit of insects. Nocturnal lizards of many species inhabit the hot countries of both continents; they are not unlike salamanders, but they have sharp claws, which they can draw in and conceal like those of a cat, and seize their prey. One of this species climbs on walls in all the countries round the Mediterranean. Chameleons are to be seen under every bush in North Africa; and different species inhabit different districts and islands in Asia; the only one that is European lives in Spain; it is also common to North Africa.

The anolis, which lives on trees, replaces the chameleon in the hot regions of South America, and in the Antilles, having the property common to chameleons of changing its colour, but it is a more nimble and beautiful animal. In



New Holland, where every thing is anomalous, there is a lizard with a leaf-shaped tail.

Skinks are exactly like serpents, with four very short feet and sharp nails on their claws, which burrow in the sands of Africa and Arabia: there is a species of gigantic black and yellow skinks in New Holland, and those in the islands of the Indian Archipelago are green, with blue tails.

Two anomalous saurians of the genus *amblyrhynchus* were discovered by Mr. Darwin in the Galipagos Archipelago. One found only in the central islands is terrestrial, and in many places it has undermined the ground with its burrows; the other is the only lizard known that lives on sea-weed, and inhabits the sea; it is about four feet long, and hideously ugly, with feet partially webbed and a tail compressed laterally. It basks on the beach, and in its marine habits and food it resembles, on a small scale, the huge monsters of a former creation.

Tortoises are covered with a shell or buckler, but their heads, legs, and tail are free, covered with a wrinkled skin, and the animal can draw them into the shell when alarmed. The head is sometimes defended by a regular shield, and the jaws, instead of teeth, have a horny case. The upper buckler is rounded, and formed of eight pairs of plates symmetrically disposed, and often very beautiful; the under shell is flat, and consists of four pair of bones and one in the centre. One family of tortoises is terrestrial, two others are amphibious, one of which lives in fresh water, the other in tropical and warm seas.

There are more land tortoises in Africa than in all the rest of the world, both specifically and individually. There are several European species, of which the Greek tortoise, common in all the countries round the Mediterranean, is the largest, being about a foot long; it lives on insects and vegetables, and burrows in the ground in winter. Some of the East Indian species are enormously large, above three feet long, and remarkable for the beautiful distribution of their colours; some species are peculiar to Brazil, one to Demarara, and one to North America.

There are two families of the fresh-water tortoises that live in ponds and ditches. The *emys* is very numerous in America; there are 15 species peculiar to the northern part of the continent, and four to the southern: only one has been found



in Africa, two in Europe and eight in Asia. South America is the country of the chelydæ, which feed only when in the water; there are none in North America, five in Africa, and one in Australia.

The trionyx, or fresh-water turtle, lives in the great rivers and lakes in warm countries; there are two species peculiar to North America: they are very large, eat birds, reptiles, and young crocodiles, and often are a prey to old ones. One is peculiar to the Nile, one to the Euphrates, but the Ganges is their principal abode; there are four species which are constantly seen eating the bodies of the natives that are thrown into this sacred stream; one of these turtles often weighs 240 pounds. The starred trionyx is in the rivers of Java only, and another kind is common also to the rivers of Borneo and Sumatra.

The cheloniadæ, or sea turtle, live in the seas of the torrid and temperate zones, to the 50th parallel of latitude, some eating algæ, and others molluscas and radiated fish. Different species are found in different parts of the ocean. The green turtle, of which there are many varieties, inhabits the intertropical Atlantic; they are seen in shoals eating sea-weed at the bottom of the water along the coast, but they come to the mouth of rivers to lay their eggs in the sand. This turtle is often six or seven feet long, and weighs 600 or 700 pounds; it is much esteemed for food, but the shell is of no value. There are two species in the Mediterranean, which are only valued for the oil.

With respect to the whole class of reptiles it may be observed, that not one species is common to the old and new world, and few are common to North and South America; those in New Holland are altogether peculiar; and, with the exception of the Marianne Islands, there are neither toads, frogs, nor snakes in any of the islands of Oceanica, though the Indian Archipelago abounds in them.

Five species of reptiles only had reached Ireland before its separation from England, a lizard, a frog, a toad, and two tritons.



## CHAPTER XXIX.

## DISTRIBUTION OF BIRDS IN THE ARCTIC REGIONS—IN EUROPE, ASIA, AFRICA, AMERICA, AND THE ANTARCTIC REGIONS.

THERE is great similarity in the birds of the northern parts of the old and new continents, and many are identical. Towards the south, the forms differ more and more, till in the tropical and south temperate zones of Asia, Africa, and America they become entirely different, whole families and genera often being stationary within very narrow limits. Some birds, however, are almost universal, especially birds of prey, waders, and sea-fowl.

The bald buzzard is in every country, from Europe to Australia; the Chinese goshawk inhabits the American continent, and every station between China and the west coast of Europe; the peregrine falcon lives in Europe, America, and Australia; the common and purple herons are indigenous in the old continent and the new; and the flamingo fishes in almost every tropical river. Many of the sea-fowl also are widely spread: the wagel-gull is at home in the northern and southern oceans, and on the coasts of Australia. Captain Beechey's ship was accompanied by pintadoes during a voyage of 5000 miles in the Pacific; and even the common house-sparrow is as much at home in the villages in Bengal as it is in Britain. Many more instances might be given, but they do not interfere with the general law of special distribution.

Birds migrate to very great distances in search of food, passing the winter in one country and the summer in another, many breeding in both. In cold climates insects die or hibernate during winter; between the tropics, they either perish or sleep in the dry season: so that, in both cases, insect-eating birds are compelled to migrate. When the ground is covered with snow, the want of corn and seeds forces those kinds whose food is vegetable to seek it elsewhere; and in tropical countries the annual inundations of the rivers regulate the migrations of birds that feed on fish.



Some migrate singly, some in groups, others in flocks of thousands ; and, in most instances, the old and the young birds go separately. Those that fly in company generally have a leader, and such as fly in smaller numbers observe a certain order. Wild swans fly in the form of a wedge, wild geese in a line. Some birds are silent in their flight, others utter constant cries, especially those that migrate during night, to keep the flock together, as herons, goat-suckers, and rails.

Birds of passage in confinement show the most insurmountable disquietude when the time of migration draws near. The Canadian duck rushes impetuously to the north at the usual period of summer flight. Redbreasts, goldfinches, and orioles, brought from Canada to the United States when young, dart northwards, as if guided by the compass, as soon as they are set at liberty. Birds return to the same place year after year. Storks and swallows take possession of their former nests, and the times of their departure are exact even to a day. Various European birds spend the winter in Asia and Africa ; while many natives of these countries come to Central Europe in summer.

The birds of passage in America are more numerous, both in species and individually, than in any other country. Ducks, geese, and pigeons migrate in myriads from the severity of the northern winters ; and when there is a failure of grain in the south, different families of birds go to the north. The Virginian partridge crosses the Delaware and goes to Pennsylvania, when grain is scarce in New Jersey ; but it is so heavy on the wing, that many fall into the river, and end the journey by swimming. The same thing happens to the wild turkey, which is caught in hundreds as it arrives wet on the banks of the Ohio, Missouri, and Mississippi. These birds are not fitted for long flight by their structure, because their bones have fewer of those air-cells which give buoyancy to the feathered tribes. The number of air-cells is greatest in birds that have to sustain a continued and rapid flight ; probably the extremes are to be met with in the swift and the ostrich—the one ever on the wing, the other never. The strength of the ostrich is in the muscles of its legs ; while the muscles on the breast of the swift weigh more than all the rest of the body : hence it flies at the rate of 100 miles an hour easily. The wild duck and the wild pigeon



fly between 400 and 500 miles in a day. The stork and some other migratory birds do not halt till the end of their journey. Many sea-fowl are never seen to rest ; and all the eagles, vultures, and hawks are birds of strong flight and capable of sustaining themselves at heights beyond the reach of less buoyant creatures.

### DISTRIBUTION OF ARCTIC AND EUROPEAN BIRDS.

The birds of Europe and North America are better known than those of any part of the globe. New species are constantly discovered in Asia, Africa, and South America : and extensive regions in the east are yet unexplored : however, about 6000 have already been described.

There are 503 species of birds in Europe, many of which are distributed over Asia and Africa, without any apparent variation ; and 100 of our European species are also in North America. Of these, 39 are land-birds, 28 waders, and 62 water-fowl ; among which are most of the marine birds of northern Europe, which, like all sea-fowl, have a wider range.

More than three-fourths of the species, and a much larger proportion of individuals, of the birds of Greenland, Iceland, and Feroe, are more or less aquatic, and many of the remainder are only occasional visitors. Of the few small birds, the greater number are British ; but many that reside constantly in Britain are migratory in Iceland and Feroe, and all the small birds leave Greenland in winter. The aquila albicilla, or cinereous eagle, is the largest bird of these northern islands ; it feeds on salmon and trout, and builds its nest on the boldest crags. The jer-falcon, or falco Icelandicus, though native, is rare even in Iceland. The snowy owl lives near the glaciers in the interior of Greenland, and is sometimes seen in Orkney. Particular kinds of grouse are peculiar to high latitudes, as the ptarmigan and the white grouse. The columba ænas lives on all the rocky coasts of Europe, and it is also an American bird. The crow family are inhabitants of every part of the globe. The common crow is universal ; the carrion-crow and jackdaw are all over Europe and North America. The magpie is



everywhere in Europe. The jay, one of the most beautiful birds of its tribe, is found in Europe, North America, and China. The raven is everywhere, from Greenland to the Cape of Good Hope, and from Hudson's Bay to Mexico; it is capable of enduring the extremes of heat and cold, and is larger, stronger, and more ravenous in the Arctic islands than anywhere else. It destroys sheep and lambs, drives the eider-ducks from their nest to take their eggs or young, and they unite in flocks to chase intruding birds from their abode.

Waders are more numerous than land-birds in the Arctic regions. The snipe is a resident; the golden plover is in Feroe only; and the oyster-catcher remains all the year in Iceland: it makes its nest near streams, and wages war with the crow tribe. The heron, curlew, plover, and most of the other waders, emigrate.

Web-footed birds, being clothed with down and oily feathers, are best able to resist the cold of a polar climate. The *cygnus musicus*, or whistling swan, is the largest migratory bird of Europe or America. It is five feet long from the tip of the bill to the end of the tail, and eight feet from tip to tip of the wings: its plumage is pure white, tinged orange or yellow on the head. Some of them winter in Iceland; and in the long Arctic night their song is heard, as they pass in flocks: it is like the notes of a violin. Various species of the duck tribe live in the far north, in prodigious multitudes. The mallard, supposed to be the origin of our tame duck, is everywhere in the Arctic lands. There are two species of the eider-duck: the king duck, or *somateria spectabilis*, one of these, is widely dispersed over the islands and coasts of the North Atlantic; it lives in the open sea in winter, and resorts to the coast when the grass begins to grow. The duck makes her nest of sea-weed, lined with down from her breast. The islanders take the eggs and down twice in the season; but they do not kill the old birds, because the down of a dead duck is of no value, having lost its elasticity. The third time the drake repairs the nest with down from his breast: the birds are allowed to hatch their brood; and, as soon as the young can feed themselves, they are taken out to sea by the duck. They attain maturity in four years, and then measure two feet from tip to tip of the wing. The same couple has been known to frequent a nest



20 years, and the Icelanders think the eider-duck lives to 100.

The cormorant is universal in the northern seas, and, though living on fish, it is eaten by the natives. It sits singly, or sometimes in flocks, on the rocks, watching the fish with its keen eye: it plunges after them, and pursues them for three or four minutes under water. Auks are very numerous, especially the razor-billed auk, or penguin; but the great auk, which is incapable of flight with its little wings, is now extinct in the Arctic islands. The tern or sea-swallow, is seen everywhere in these seas, skimming along the surface of the water, catching molluscas and small fish. Gulls of many species, and in countless numbers, are inhabitants of the Arctic and Antarctic regions. No birds are more widely dispersed. They are at home, and brave the storm, in every latitude and in every sea; but those in the north are said to be larger and more numerous than elsewhere. There are nine or ten species in the Arctic regions, and the most numerous of these probably are the kittiwakes, the young of which cover the rocks in Iceland, packed so closely together, that 50 are killed at a shot.

The skua is one of the boldest and most rapacious of birds, forming a link between gulls and birds of prey. It lives by robbing other birds, and is so audacious that it forces the gulls to disgorge the fish they have swallowed, and has been seen to kill a puffin at a single blow. Its headquarters are in Feroe, Zetland, and the Hebrides, where it hatches its brood, and attacks men or animals if they come near them.

Several kinds of petrels inhabit the Arctic islands. They take their name from the faculty they have of walking on the water, which they do by the aid of their wings. The stormy petrel, the most widely diffused, is about the size of a lark, and nearly of the colour; their flight is rapid; they shelter themselves from the storm in the hollow of a wave, and go to land only at the breeding season.

It is observed that all birds living on islands fly against the wind when they go to sea, so as to have a fair wind when they return home tired. The direction of the prevailing winds, consequently, has great influence on the choice of their abode: for example, the 25 bird-rocks, or Vogel-berg, in Feroe, face the west or north-west; and no bird frequents



the cliffs facing the east, though the situation is to all appearance equally good ; a preference accounted for by the prevalence of westerly wind in these latitudes.

Most marine birds are gregarious. They build their nests on the same rock, and live in society. Of this a curious instance occurs on the rocks in question. The Vogel-berg lies in a frightful chasm among the cliffs of Westmannshaven in Feroe. The chasm is encompassed by rocks 1000 feet high, and myriads of sea-fowl cluster round the top of the crags ; but different kinds have separate habitations ; and no race or individual leaves his own quarters, or ventures to intrude upon his neighbours.

Upon some low rocks, scarcely rising above the surface of the water, sits the glossy cormorant ; the predatory skuas, on a higher shelf, are anxiously regarded by myriads of kittiwakes on nests in crowded rows along the shelving rock above, with nothing visible but the heads of the mothers almost touching one another ; the auks and guillemots are seated a stage higher on the narrow shelves, in order as on a parade, with their white breasts facing the sea, and in absolute contact. The puffins form the summit of this feathered pyramid, perched on the highest station, and scarcely discernible from its height, if they did not betray themselves by flying backwards and forwards. Some of these tribes have a watch posted to look out for their safety ; and such confidence has the flock in his vigilance, that if he is taken the rest are easily caught. When the whole take flight, the ear is stunned by their discordant screams.\*

The greater part of the marine birds of the Arctic seas are inhabitants also of the northern coasts of the continent of Europe and of the British Islands.

No part of Europe is richer in birds than Britain, both in species and numbers of individuals ; and the larger game is so abundant, that no one thinks of eating nightingales and redbreasts. Of the 503 species of European birds, 277 are native in our islands. The common grouse, the yellow and pied wagtails, and the English starling, are found nowhere else. Most of the British birds came from Germany before the separation of our island from the continent, and many of short flight never reached Ireland. The ptarmigans and capercailly came from Norway.

\* Trevelyan's Travels in Iceland and the Feroe Islands.



There are five European vultures : the lammergeyer of the Alps and Pyrenees, the largest of these, builds its nest in the most inaccessible parts of the mountains, and is seldom seen ; it lives also in the mountains of Abyssinia and on the Mongolian steppes. Ten eagles are European ; one is peculiar to Sardinia ; and several of them are common in America : the golden eagle is one ; that beautiful bird, which once gave a characteristic wildness to our Scotch mountains, and the distinguishing feather to the bonnet of our chieftains, is now nearly extirpated. The osprey or fishing eagle is equally an inhabitant of Europe and America, and so are some of our numerous hawks ; among others the jer or gentil falcon has been so much destroyed, that it is now rare even in Iceland, its native place : there are still a few in Scotland, and several are caught in their migratory flight over the Low Countries, and reclaimed by the expert falconers for the now nearly obsolete sport of falconry.

The owl tribe is numerous, and many of them are very handsome. The *bubo maximus*, the great owl, the largest of nocturnal birds, inhabits the forests of middle and southern Europe ; it is rare in France and England, though not uncommon in Ireland and Orkney : in Italy a small owl is tamed and used as a decoy.

Owls, eagles, and hawks have representatives in every country, but of different species. The two species of European goat-suckers migrate to Africa in winter ; their peculiar cry may be heard on a moonlight night when a large flock takes wing for the journey. Several of our swallows go to Africa : both our kingfishers are African, and only visit us in summer ; one, the *alcyon ispida*, is a native of Lower Egypt and the Red Sea. Some of the seven species of European creeping birds, or *certhias*, creep on the trunks and branches of trees in search of insects ; others pursue their prey clinging to the face of rocks and walls, supported by the stiff elastic feathers of the tail : the hoopoe, an inhabitant of southern Europe, is also a creeper, but it pursues small reptiles and insects on the ground.

The sylvias and thickbilled birds are by much the most characteristic of Europe ; to them belong our finest songsters. The sylvias have soft beaks, and feed on insects and worms ; the nightingale, thrush, blackbird, wren, the beccafico, the smallest of European birds, the warblers, white-



throat, and others, are of this family. Thick-billed birds live on seed, as the goldfinch and other finches, linnets, larks, buntings, and crossbeaks.

Four species of fly-catchers are peculiar to Europe, and five species of shrikes. Ravens, crows, jays, and magpies, are everywhere; the Alpine crow and nutcracker are in central Europe only. Compared with America the starling family is poor, and the woodpecker race still more so, yet we have six species, some of which are very beautiful. There is only one cuckoo entirely European, the other two kinds only come accidentally, and all are birds of passage. There are four species of the pigeon tribe; the ringdove frequents the larch forests, and is migratory; the stockdove also leaves us in October; the biset or rock pigeon, supposed to be the origin from which the infinite variety of our domestic pigeons has sprung, flies in flocks, and makes its flimsy nest on trees and rocks; it is also found in the Da-ouria part of the Altaï chain. Of gallinaceous birds there are many; the only native pheasant is in the southwestern parts of the continent; and the capercailly, extinct in the British forests, inhabits many parts of Europe, in Scandinavia especially it is plentiful as far as the pine-tree grows, which is nearly to Cape North, and also in the Russian forests. The hazel-grouse frequents the pine and aspen forests in central and northern Europe, where the black cock also is plentiful. Five species of grouse and six of partridges afford abundance of game; four of the latter are confined to the southern parts of the continent, and so are the sand and pen-tailed grouse, which form a separate family; the former inhabits the sterile plains of Andalusia and Granada, and the latter the stony uncultivated parts of France, southern Italy, and Sicily. The *ortigis gibraltarica* is a peculiar bird allied to the grouse family, found in the south of Europe only.

European waders are very numerous, and among them there are specimens of all the genera: woodcocks, snipes, plovers, curlews, and grebes, are very abundant, and herons of various species; three of them are egrets or crested herons, and the common heron now assembles on the tops of trees unmolested, since the progress of agriculture has rendered the country unfit for hawking. Several cranes and storks, and two species of ibis, are European: the flamingo is met with in the south-eastern parts of the continent, and in the



maremme on the east coast of Italy. Many of the wading tribes, however, migrate in winter. The stork, so great a favourite in Holland that it is specially protected, is a wanderer; it retreats to Asia Minor, and on the return of summer resumes its old nest on a chimney-top, breeding in both countries. Europe is particularly rich in web-footed birds; there are four species of wild swans, four of wild geese, and more than 30 of the duck tribe, including the inhabitants of the Arctic seas.

### BIRDS OF ASIA AND THE INDIAN ARCHIPELAGO.

European birds are widely spread over Asia; most of the Arctic sea-fowl frequent its northern coasts: between 50 and 60 European birds are also Siberian, and there are above 70 European species in Japan and Corea, which probably are also inhabitants of Siberia and the Altaï Mountains, and several are identical with the birds of North America, so that the same affinity prevails in the feathery tribes of the Arctic regions as in the vegetable productions.

Asia Minor is a country of transition, and many European birds inhabit the Caucasus, the shores of the Caspian Sea, and Persia. Moreover these warmer climates are the winter-quarters of various European species.

In Asia Minor, and especially in Armenia, the number and variety of birds is very great; large eagles, vultures, falcons, buzzards, quails, partridges, starlings, herons, storks, cranes, legions of Arctic grebes, swans, wild geese, ducks and pelicans, are natives of these countries; besides singing-birds, the nightingale, the constant theme of the poet's song, abounds in Persia: hawks are trained for hunting deer in that country, and the Asiatic partridges, or francolins, more vividly coloured than ours, differ also in having beaks fitted for digging up bulbous roots, which is their food in the deserts.

Farther east the types become more Indian; the great peninsulas on each side of the Ganges are the habitations of the most peculiar and the most gorgeous of birds. Many species, and some entire genera, of kingfishers are here, of the gaudiest colouring; the plumage of the fly-catchers has the richest metallic lustre; and the shrikes, of a sober hue with us, are there decked in the brightest colours: the drongo has



a coat of ultramarine, and the calyptomene has one of emerald green.

The large-beaked climbing-birds are singularly handsome. The great green parrot, so easily taught to speak, has inhabited the Indian forests and the banks of the Ganges time out of mind, with a host of family connections and congeners of every colour; not one species of these, or indeed of the whole parrot tribe, is common to Asia, Africa, America, or Australia, nor even to any two of these great continents. They are vividly coloured in India, but the cuckoo tribe rivals them; several genera of these birds exist nowhere else, as the large-beaked malcahos, the coucals with their stiff feathers, and the couroucous or trogons, dressed in vermilion and gold; the last, however, also inhabit other tropical climates.

Eastern Asia is distinguished by the variety of its gallinaceous birds and the gorgeousness of their plumage. To this country we owe some of our domestic fowls; the cock and hen, and two species of peacock, are wild in the woods in India and Ceylon. The polyplectron, the only bird of its kind, and the trogopons, are Indian; and some of the most brilliant birds of the East are among the pheasant tribe, of which five species are peculiar to China and Tibet. There are various species of the horned pheasant in the Himalaya, and one whose feathers have a metallic lustre. The gold, the silver, and Reeves' pheasant, the tail-feathers of which are four feet long, belong to China. The lophophorus refulgens, and some others of that genus, are altogether Indian.

The pigeons also are very splendid in their plumage; they mostly belong to China and Japan; those in the Birman Empire are green.

It would be vain to enumerate the fine birds that range in the forests, or fish in the rivers of the Asiatic continent, yet the birds of the Indian Archipelago far surpass them in splendour of plumage; these islands indeed are the abode of the most gorgeously arrayed birds in existence. Even in Java and Sumatra, though most similar to India in their winged inhabitants, there are many peculiar, especially 12 or 13 species of the climbing tribe, and several of the honey-sucking kind; but the dissimilarity increases with the distance, as in New Guinea and its islands, where the honey-sucking genera are developed in novel forms and sumptuous plumage.



In the various islands of the archipelago there are altogether at least 15 genera, with their numerous species, found there only. There are the cassicans, which resemble jays, with plumage of metallic lustre; the only two species of pirolls, one bright violet, the other of brilliant green; various species of calaos with large horned beaks, oriols of vivid colours, the swallow that builds the edible nest, and every variety of birds of paradise; the most numerous and splendid sylvans, and all the species but one of the philedons or honey-sucking birds with tongues that end in a brush. The pigeons are peculiarly beautiful and numerous, but limited in their abode. The gouroa, or great crowned pigeon, the largest of its tribe, is an inhabitant of Borneo. Each island has its own species of louries, which exist nowhere else; many peculiar paroquets and cockatoos, couroucous or trogons, coucals, and the barbu, with huge beaks, are all peculiar to these islands. Even the partridges have thrown aside their grave colours and assumed the vivid hues of the tropics, as the green and tufted cryptonex. But the other gallinaceous birds far surpass them, as the fire and the argus pheasant, and two or three species still more splendid, with a host of other birds already known, and multitudes which Europeans never have seen, in the deep jungles and impenetrable forests of these unexplored islands. The casuary, a bird akin to the ostrich, without the power of flying, but fleet in its course, has a wide range in these countries, and, though destitute of beauty, is interesting from its peculiar location and the character of the whole race.

### AFRICAN BIRDS.

A great number of European birds are also inhabitants of Africa, and many migrate there in winter, yet the birds of this continent are very peculiar and characteristic; those in the north and north-east, and at the Cape of Good Hope, are best known, but the greater part of tropical Africa is still unexplored. It may be observed, generally, that the tropical birds differ from those of North Africa, but are, with a few exceptions, the same with those in the southern part of the continent, and the whole of Africa south of the desert differs in species from those of north and western Africa and from



Europe. Moreover, there is a strong analogy, though no affinity, between the birds of Africa and America in the same parallels of latitude; there is not a single perching bird common to the two, though some of the rapacious are in both.

There are 59 species of birds of prey, of which a few are also European. The secretary bird is the most singular of this order: it is a vulture which preys upon serpents at the Cape of Good Hope, in Abyssinia, and other parts of the continent. Africa possesses at least 300 species of the passerine order, of which 10 genera, with all their species, are peculiarly its own. The swallows are more beautiful than ours, especially the *cecropis striata*, with two tail-feathers twice as long as its body. Many kingfishers, the most beautifully coloured of their brilliant race, frequent the lakes and rivers; four species of hoopoes, one of which visits Europe in summer, are natives; and the honey-birds, the representatives of the humming-birds of South America, are peculiarly African. They abound at the Cape of Good Hope, where the nectaries of proteas and other plants produce the saccharine juice which is their food. The *malurus Africanus*, and many other singing-birds for the most part unknown elsewhere, inhabit the forests. The canary-bird is confined to the Canary Islands; its song differs in different parts, and even in two adjacent districts: there are, however, other instances of this. The capirote, also indigenous in the Canary Islands, is a finer songster, but it cannot be tamed. Various shrikes are peculiar to Africa, but the species known as the grand baratra is confined to the Azores. There are several birds of the raven tribe, or nearly akin to them: as the *lampratornis superba*; another with purple wings, the *buphaga*, the only bird of its genus; and several species of the calaos. The weaving-bird, or *textor*, is one of the most remarkable of the graminivorous tribe; it weaves its nest with grass and twigs very dexterously: one brought to Europe wove a quantity of thread among the wires of its cage, with great assiduity, into a strong texture. The widow-bird, the calious, the blue bee-eater, and all the fly-catching touracous, with many species of woodpeckers, are found nowhere else. The parrots and paroquets, which swarm in the tropical forests, from the size of a hen to that of a sparrow, are of original forms. The trogons, or couroucous, the most beautiful of the large-beaked



climbing-birds, are the same as in Asia; but the barbu and the four species of barbicans are altogether African, and so are some of the cuckoos. Among the latter are two species of the cuculus indicator, so named from indicating where the bees have their nests; one is peculiar to Abyssinia, the other to the interior at the Cape of Good Hope; and mocking-birds are spread over a wide extent of this continent.

There are at least 13 species of African pigeons; and to Africa we are indebted for the guinea-fowl, of which there are three or four kinds: it wanders in flocks of hundreds among the brushwood on the banks of rivers and lakes in Numidia and all the tropical regions, and they are even more abundant in Madagascar. Many grouse and partridges are peculiar, especially the gangas, of which there are five species: some go in coveys, and others traverse the deserts in flocks of many hundreds. The sand-grouse, one of this family, is much more abundant on the arid deserts of North Africa than in Europe; and the partridges of this country are francolins which feed on bulbous roots.

The ostrich takes the wide range of Africa and Arabia; the bird of the desert, and bustards, also wanderers in the plains, are numerous: the most peculiar are the rhaad and the otis kori, in South Africa, five feet high, and remarkable for the brilliancy of its eye.

Waders of infinite variety inhabit the rivers, lakes, and marshes—woodcocks, snipes, plovers, storks, cranes, herons, and spoonbills. The most peculiar are the dromes and marabouts, whose feathers form a considerable article of commerce; the cream-coloured plover, the scopus or umbrette, the water-treader of Abyssinia, and the tantalus tribe, among which is the falcinellus, known in Africa only, and the ibis, once held sacred in Egypt, and frequently found in mummies in the catacombs.

Swimming-birds are no less numerous: the bernicla cyanaptera is a goose peculiar to Shoa; the rhynchops and pelicans, several of the duck kind or birds allied to them, are found nowhere else.

## BIRDS OF NORTH AMERICA.

Of 471 species of North American birds, about 100 are also found in Europe, the greater number of which are water-



fowl, and those common to the northern coasts of both continents. The sea-fowl on the North Pacific and Behring's Straits are very much the same with those in the Greenland seas and the North Atlantic, but the great auk or penguin, with featherless wings, still exists on the North Pacific, and the great albatross, seldom seen in the North Atlantic, frequents Behring's Straits and the western coasts of North America in immense flocks. It is almost universal in the Pacific and in the stormy regions towards each pole. Like Mother-Cary's-chickens, it is a bird of the storm, sailing calmly on its huge wings in the most tremendous tempests, and following a ship a whole day without resting on the waves: it is the largest of sea-fowls; some measure 17 feet from tip to tip of the wings.

There is no vulture common to the two continents, but there are five eagles, half of the other birds of prey, a fourth part of the crow tribe, several waders and web-footed birds which inhabit both; yet the general character of North American birds is different from that of European: 81 American generic forms and two families are not found in Europe. The humming-birds are altogether American; only four species are in North America; one of these is migratory, and another is common to South America. The parrot family, distributed with generic differences in almost all tropical countries, has but one representative here, which lives in the forests of the Carolinas. Europe has nothing analogous to these two families. It is singular that a country with so many rivers and lakes should possess only one kingfisher. The woods are filled with many species of creeping birds, and there are 68 peculiar species of sylvias and flycatchers; among others the *todus viridis*, which forms a genus by itself. Ravens, crows, pies, and jays abound, and there are 13 species of starlings. The finch tribe are very numerous, and there are 16 species of woodpeckers, as might be expected in a country covered with forests. Of pigeons there are eight species, but individually they are innumerable, especially the *columba migratoria*, which passes over Canada and the northern States in myriads for successive days twice in the year. The poultry-yard is indebted to North America for the turkey, which there ranges wild in its native woods and attains great size. There are no partridges, and of 13 American species of grouse three are



European, a family which exists in every country under different forms. The vast expanse of water and marshy ground makes North America the home of water-fowl and waders without end. Most of the waders and graminivorous birds are migratory ; in winter they find no food north of the great lakes, where the ground is frozen upwards of six months in the year. Many pass the winter in California, as storks and cranes ; wild geese cover acres of ground near the sea, and when they take wing their clang is heard far off. Blackbirds are as numerous ; even gulls and other northern sea-fowl come to the coasts of California, and indeed to the shores of all the north and temperate Pacific.

It may be said generally that, with regard to the web-footed tribe, North America possesses specimens of all the genera of the old world and many peculiarly its own. The table-land of Mexico has some peculiar forms, and some species of swimming-birds found only in more northern latitudes ; but, except the *ampelidæ*, there are representatives of every group of North and South America.

### BIRDS OF SOUTH AMERICA.

The tenants of the air in South America differ more from those in North America than these do from the birds of Europe : there are not more than 50 or 60 species in common. South America has a greater variety of original forms than any other country ; more than 25 genera with all their species inhabit that country only ; of the passerine family alone there are at least 1000 species, all peculiar. The vultures are of different genera from those in Europe : the condor of the Andes is the largest of these ; it is so fierce that it even attacks the puma, the lion of America ; it frequents the highest pinnacles of the Andes in summer, and soars to the height of 15,000 feet above the earth. In winter it descends in groups to feed on the plains and sea-shore ; and, like all the vulture race, it possesses the faculty of descrying a dead or dying animal long before it is itself visible in the air : it never goes beyond the isthmus of Panama : the condor of California is a smaller bird. The three species of the vultur papa, or king of the vultures, are remarkable for the bright blue and vermilion colour of the



head and neck ; the black vulture lives in large assemblies on the tops of high trees in the sylvas, and another numerous species prey on animals in the llanos. Many other rapacious birds are peculiar to this continent ; the burrowing owl, so common in the Pampas and Chili, is one of these. The guachero forms a genus by itself ; it is of the size of a common fowl, with the form and beak of a vulture, and is the only instance known of a nocturnal bird feeding on fruit. It is confined to a limited district of Cumana, and shuns the light : incredible numbers have taken possession of a dark cavern in the valley of Caripa, where they are killed in thousands every year by the Indians for their fat.

The troupials represent our orioles, the baratras and becardes our shrikes, while the tangaras partake of the form both of the shrike and pie, which last, with all the rest of the crow family, have various representatives in this country. Swallows, or birds allied to them, are numerous, and many that live on the honeyed juice of flowers, like the humming-bird, so peculiarly characteristic of South America : 150 species of humming-birds, from the size of a wren to that of a humble-bee, adorn the tropical regions of Brazil and Guiana. This family, so entirely American, has a range from the Straits of Magellan to the 38th parallel of N. lat. and even to Cook's Straits. There is only one South American humming-bird, which is also permanent in the United States, and only two are found in Central America : many of them are migratory ; they come in multitudes to North Chili in summer and disappear in winter. The climbing-birds, with large bills, are mostly confined to the tropical forests, which swarm with peculiar races of parrots, paroquets, and macaws, and with whole families of birds not to be seen elsewhere ; as the vividly-coloured toucan, with its huge beak ; the *auraucari*, which lives on the fruit of the *auraucari* pine ; some peculiar species of the gorgeous trogons or couroucous ; the *tomalias*, birds related to the cuckoo tribe ; and the *jacmars*, which represent the woodpeckers.

The gallinaceous family is totally different from that in the Indian forests ; the guan or penelope, related to the pheasant, and the tinamous, something of the grouse kind, supply their place, together with various alectors, which run after lizards and snakes on the plains, or feed on insects on the banks of rivers. Some of them have a horny substance on



the wings for striking their prey : the most peculiar of these alectors are the agami or trumpet bird, the kamichi, and the caziamá, of Brazil. No country can be compared with South America for the number of original forms of birds, far beyond even being mentioned in a book not entirely devoted to natural history.

The ostrich with three toes, or *struthia rhea*, ranges, like all its congeners, over a wide extent of country. It is everywhere from the Silvas to the Rio Negro, which bounds the Pampas of Buenos Ayres ; while the *struthia Darwinii* has the plains of Patagonia to the Straits of Magellan for its residence.

The water-fowl and waders in this land of rivers are beyond number ; millions of flamingoes, spatules, cormorants, herons, fishing-falcons, and rynchops, follow the fish that go up the rivers to spawn ; nor are gulls wanting where fish are to be found : a little snow-white heron walks on the back and over the head of the crocodile while it sleeps. The water-fowl are almost all peculiar ; the few that are excepted are North American. Eight or nine genera belonging to the warm climates of the old world, are here under new forms, and the number of specific forms of the same genus is greater than in any other country. The *tantalus ruber* inhabits Cayenne ; the *ardea helias* and *scalopax* are the most peculiar of the herons.

Ducks migrate in immense flocks, alternately between the Orinoco and the Amazons, on account of the greater supply of fish afforded by the floods of these rivers, which take place at intervals of six months from each other. Between the tropics the vicissitudes of drought and humidity have much influence on the migration of birds, because the supply of their food depends upon these changes.

If any thing more were required to show the partial location of birds, the Galapagos Archipelago might be mentioned : of 26 specimens shot by Mr. Darwin, 25 were peculiar, though bearing a strong resemblance to American types ; some birds were even confined to particular islands ; and the gulls, one of the most widely dispersed families, are peculiar. But on this comparatively recent volcanic group, only 500 miles distant from the coast of America, every thing is peculiar, birds, plants, reptiles, and fish, and though under the equator, all have sober covering.



The coasts of Peru and northern Chili are not rich in birds, but in southern Chili there are many humming-birds, parrots, giant storks, flamingoes, peculiar ducks and geese; and there begins that inconceivable quantity of sea-fowl that swarm on the seas and coasts of the Antarctic regions. The black rayador, or *rhynchops nigra*, has been seen in a dense mass seven miles long; shags fly in an unbroken line two miles long. Pelicans, sea-ravens, gulls, petrels, and many others cover the low islands and coasts of the mainland, and those of Tierra del Fuego.

In the Antarctic seas petrels take place of our gulls; seven species of them inhabit these high southern latitudes in prodigious numbers. A flock of what was supposed to be the young of the kind known as the Cape pigeon, was estimated to have been from six to ten miles long, and two or three miles broad, which absolutely darkened the air during the two or three hours they were flying over the discovery ships. The white petrel, a most elegant bird, never leaves the ice, and consequently is never seen north of the Antarctic circle in summer. Three species of penguin inhabit these seas; the largest, which is a rare and, for the most part, solitary bird, lives on the pack-ice, and weighs from 60 to 70 pounds. The other two species are smaller and gregarious; they crowd the snow-clad islands in the high southern latitudes in myriads: every ledge of rock swarms with them, and on the shore of Possession Island, close to Victoria Land, it was difficult to pass through the multitudes. They are fine, bold birds, pecking and snapping with their sharp bills at those who venture among them. They can scarcely walk, and cannot fly, but they skim along the snow, and swim rapidly, even under water, and the noise they make baffles all description. Two species of albatross breed in the Antarctic Islands; a kind of skua gull, which robs their nests; and a goose which, like the eider-duck, makes its nest with the down from its breast. Few land-birds are met with within the Antarctic circle: there are but seven or eight species in the Auckland Islands, mostly New Zealand birds; among others, the tooa or tui, and an olive-coloured creeper, the choristers of the woods. One only was found in Campbell Island.

Many generic forms are the same at the two extremities of the globe, yet with distinct specific differences. Sea-fowls



are more excursive than other birds, but even they confine themselves within definite limits, so that the coasts may be known from their winged inhabitants.

### AUSTRALIAN BIRDS.

The Australian birds are in many respects as singular as the quadrupeds and plants of that country: a white falcon is among its birds of prey, a black swan among its waterfowl, and of 45 genera, 35 are purely Australian. The passerines are so original, that many new genera have been found. The cassican, a handsome bird of bright colours, approaching somewhat to the crow family, the chouealcyon, the golden and black oriole, and one species of phelidon, are peculiar Australian. The menura superba, or lyre-bird, from the resemblance its out-spread tail bears to the ancient lyre, is the only bird of its genus, and the only one which approaches the character of the gallinaceous family, of which none have been discovered in the Australian continent. Here are many specific kinds of cuckoos, as the coucals and the scythrops, the only bird of its genus. Woodpeckers there are none. The parrots, paroquets, and cockatoos, which live in numerous societies, all are peculiar, especially the black cockatoo, which is found here only; it is not so gregarious, but even more suspicious than the white cockatoos, which have a sentinel to warn them of danger. Chious, with huge bills like the toucan, satin-birds, pigeons and doves of original forms, abound; and the cereops goose is no less peculiar among the web-footed tribe. The desert plains of this great continent are allotted to the emu, a large struthia, like its congener the ostrich, incapable of flight, and once very plentiful, but now in progress of being extirpated or driven by the colonists to the unexplored regions of the interior.

The apteryx, a bird of the same family, still lingers in New Zealand, but it is on the verge of extinction, and probably owes its existence to its nocturnal and burrowing habits. It is one of those anomalous creatures that partakes of the character of several others; its head is in some degree like that of the ibis, with a long slender bill, fitted for digging into the ground for worms and grubs; its legs and feet resemble those of the common fowl, with a fourth toe or spur



behind, in which it differs from its congeners; and its wings, if wings they can be called, are exceedingly small. In a specimen, whose body measured 19 inches, the wings, stripped of the feathers, were only an inch and a half long, ending in a hard horny claw three inches long. The comparatively small wings are characteristic of the whole family: the rhea and ostrich have the largest, which, though unavailing in flight, materially aid their progress in running; the wings of the emu and apteryx serve only as weapons of defence: the whole tribe also defend themselves by kicking. No animals have a more remarkable geographical distribution than this family, or show more distinctly the decided limits within which animals have originally been placed. These huge birds can neither fly nor swim, consequently they could not have passed through the air or the ocean to distant continents and islands. There are five distinct genera, to each of which very extensive and widely separated countries have been allotted: the ostrich is spread over Africa, from the Cape of Good Hope to the deserts of Arabia; two species of the rhea range over the plains of the Pampas and Patagonia, in South America; the continent of Australia is the abode of the emu; the cassowary roves over some of the large islands of the Indian Archipelago; and the apteryx dwells in New Zealand. The dodo, a very large bird of the struthia kind, extirpated by the Dutch navigators, once inhabited Mauritius and the adjacent island of Don Rodriguez. The *deinornis giganteus*, a bird 10 feet high, has been recently extinguished in New Zealand, if there be not still some lingering in the unexplored part of that wide country, the only one that has contained two genera of this family of birds. Bones, not fossilized, but in the natural state, have been found of six species of this extraordinary bird, and brought to England; and a complete skeleton of the *deinornis giganteus* has been arranged by Professor Owen, the distinguished comparative anatomist, to whom we are indebted for a very interesting account of it. A small portion of a large bone was examined by him, and the result was one of those triumphs of science which characterize genius: he boldly pronounced it to be the bone of a bird—of the ostrich kind, and his decision has since been abundantly confirmed by the subsequent discovery of the bones and part of the egg of the bird.



The struthia family live on vegetables ; the form of those that had their home in New Zealand shows that they had fed on the edible roots of the fern which covers that country ; and as no quadruped excepting a rat is indigenous in New Zealand, though 700 miles long, and in many places 90 wide, these birds could have had no enemy but man, the most formidable of all.

The beautiful and sprightly tui, or parson bird, native in New Zealand, is jet black, with a white tuft on its breast, and so imitative that it can be taught to repeat whole sentences. There are parrots and paroquets, vast numbers of pigeons, fine warblers, many small birds, and a great variety of water-fowl, amongst others a cormorant, which, though web-footed, perches on the trees that overhang the streams and sea, watching for fish ; and a snow-white frigate-bird, that pounces on them from a great height in the air. Altogether there are at least 84 species of birds that inhabit these islands.

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## CHAPTER XXX.

### DISTRIBUTION OF MAMMALIA THROUGHOUT THE EARTH.

CARBONIC acid, water, and ammonia, contain the elements necessary for the support of animals, as well as of vegetables. They are supplied to the graminivora in the vegetable food which is converted into animal substance by their vital functions.

Vitality in animals, as in vegetables, is the power they have of assimilating their food, a process independent of volition, since it is carried on during sleep, and is the cause of force. Animals inhale oxygen with the air they breathe ; part of the oxygen combines with the carbon contained in the food, and is exhaled in the form of carbonic acid gas. With every effort, with every breath, and with every motion, voluntary or involuntary, at every instant of life, a part of the muscular substance becomes dead, separates from the living part, combines with the remaining portion of inhaled oxygen, and is removed. Food, therefore, is necessary to compensate for the waste, to supply nourishment, and to re-



store strength to the nerves, on which all vital motion depends; for by the nerves volition acts on living matter. Food would not be sufficient to make up for this waste, and consequent loss of strength, without sleep; during which voluntary motion ceases, and the undisturbed assimilation of the food suffices to restore strength, and to make up for the involuntary motion of breathing, which is also a source of waste.

The perpetual combination of the oxygen of the atmosphere with the carbon of the food, and with the effete substance of the body, is a real combustion, and is supposed to be the cause of animal heat, because heat is constantly given out by the combination of carbon and oxygen; and, without a constant supply of food, the oxygen would soon consume the whole animal, except the bones.

Graminivorous animals inhale oxygen in breathing, they also take it in by the pores of the skin; and as vegetable food does not contain so much carbon as animal food, they require a greater supply to compensate for the wasting influence of the oxygen; therefore, cattle are constantly eating. But the nutritious parts of vegetables are identical in composition with the chief constituents of the blood; and from blood every part of the animal body, and even a portion of the bones, is formed.

Carnivorous animals have not pores in the skin, therefore their supply of oxygen is from their breath only; and, as animal food contains a greater quantity of carbon, they do not require to eat so often as animals that feed on vegetables. The restlessness of carnivorous animals, when confined in a cage, is owing to the superabundance of carbon in their food. They move about continually to quicken respiration, and by that means procure a supply of oxygen to carry off the redundant carbon.

The quantity of animal heat is in proportion to the amount of the oxygen inspired in equal times. The heat of birds is greater than that of quadrupeds, and in both it is higher than the temperature of amphibious animals, and fishes, which have the coldest blood. On these subjects we are indebted to Professor Liebig, who has thrown so much light on the important sciences of animal and vegetable chemistry.

The mammalia consist of nine orders of animals, which differ in appearance and in their nature; but they agree in



the one attribute of suckling their young. These orders are—the quadrumana, animals with four hands, as monkeys and apes; cheiroptera, animals with winged hands, as bats; carnivora, that live on animal food, as the lion and tiger; rodentia, or gnawers, as beavers, squirrels, mice; edentata, or toothless animals, as ant-eaters and armadilloes; pachydermata, or thick-skinned animals, as the elephant, the horse; ruminantia, animals that chew the cud, as cows, sheep, deer; cetaceæ, as whales, dolphins, and phocæ.

The distribution of animals is guided by laws analogous to those which regulate the distribution of plants, insects, fishes, and birds. Each continent, and even different parts of the same continent, are centres of zoological families, which have always existed there, and nowhere else; each group being almost always specifically different from all others.

Food, security, and temperature have no influence, as primary causes, in the distribution of animals. The plains of America are not less fit for rearing oxen than the meadows of Europe; yet the common ox was not found in that continent at the time of its discovery; and, with regard to temperature, this animal thrives on the llanos of Venezuela and the pampas of Brazil as well as on the steppes in Europe. The horse is another example: originally a native of the deserts of Tartary, he now roams wild in herds of hundreds of thousands on the grassy plains of America, though unknown in that continent at the time of the Spanish invasion. The stations which the different families now occupy must have been allotted to them as each part of the land rose above the ocean; and because they have found in these stations all that was necessary for their existence, many have never wandered from them, notwithstanding their powers of locomotion; while others have migrated, but only within certain bounds.

The Arctic regions form a district common to Europe, Asia, and America. On this account, the animals inhabiting the northern parts of these continents are sometimes identical, often very similar; in fact, there is no genus of quadrupeds in the Arctic regions that is not found in the three continents, though there are only 27 species common to all, and these are mostly fur-bearing animals. In the temperate zone of Europe and Asia, which forms an uninterrupted region, identity of species is occasionally met with; but for the most part



marked by such varieties in size and colour as might be expected to arise from difference of food and climate. The same genera are sometimes found in the intertropical parts of Asia, Africa, and America, but the same species never; much less in the south temperate zones of these continents, where all the animals are different, whether birds, beasts, insects, or reptiles; but in similar climates analogous tribes replace one another.

Europe has no family and no order peculiarly its own, and many of its species are common to other countries; consequently the great zoological districts, where the subject is viewed on a broad scale, are Asia, Africa, Oceanica, America, and Australia; but in each of these there are smaller districts, to which particular genera and families are confined. Yet when the regions are not separated by lofty mountain-chains, acting as barriers, the races are in most cases blended together on the confines between the two districts, so that there is not a sudden change.

### EUROPEAN ANIMALS.

The character of the animals of temperate Europe has been more changed by the progress of civilization than that of any other quarter of the globe. Many of its original inhabitants have been extirpated, and new races introduced; but it seems always to have had various animals capable of being domesticated. The wild cattle in the parks of the Duke of Hamilton and the Earl of Tankerville are the only remnants of the ancient inhabitants of the British forests, though they were spread over Europe, and perhaps were the parent stock from which the European cattle of the present time have descended; though the bison, or euroch, a race nearly extinct, and found only in the forests of Lithuania and the Caucasus, may have some claim to the pedigree. Both races are supposed to have come from Asia. The musmon, which exists in Corsica and Sardinia, is said to be the origin from which our sheep sprung. The pig, the goat, the fallow-deer, and red-deer, have been reclaimed, and also the reindeer, which cannot strictly be called European, since it also inhabits the northern regions of Asia and America. The cat is European; and altogether eight or ten species of tamed quadrupeds have sprung from native animals.



There are still about 180 wild land-animals in Europe : 45 of these are also found in western Asia, and nine in northern Africa. The most remarkable are the reindeer, elk, red and fallow deer, the roe-buck, glutton, lynx, polecat, several wild-cats, the common and black squirrels, the fox, wild boar, wolf, the black and the brown bear, eight species of weazels, and seven of mice. The otter is common ; but the beaver is now found only on the Rhine, the Rhone, the Danube, and some other large rivers ; rabbits and hares are numerous ; the hedgehog is everywhere ; the porcupine in southern Europe only ; the chamois, yzard, and ibex in the Alps and Pyrenees. Many species of these animals are widely distributed over Europe, generally with variations in size and colour. The chamois of the Alps and Pyrenees, though the same in species, is slightly varied in appearance ; and the fox of the most northern parts of Europe is larger than that in Italy, with a richer fur, and somewhat different colour.

Some European animals are much circumscribed in their locality. The ichneumon is peculiar to Spain ; a peculiar species of stag and the musmon are confined to Corsica and Sardinia ; there are a weazel and bat which inhabit Sardinia only ; and Sicily has several peculiar species of bats and mice. There is only one species of monkey in Europe, which lives on the rock of Gibraltar, and is supposed to have been brought from Africa. All the indigenous British quadrupeds now existing, together with the hyæna, tiger, bear, and wolf, whose bones have been found in caverns, came from Germany before England was cut off from the continent by the British Channel ; but the greater number have perished. Ireland was separated by the Irish Channel before all the animals had migrated across England ; so that our squirrel, mole, polecat, dormouse, and many smaller quadrupeds, never reached the sister island.

### ASIATIC ANIMALS.

Asia has a greater number and a greater variety of wild animals than any country, except America, and also a larger proportion of those that are domesticated. Though civilized from the earliest ages, the destruction of the animal creation



has not been so great as in Europe, owing to the inaccessible height of the mountains, the extent of the plains and deserts, and, not least, to the impenetrable forests and jungles, which afford them a safe retreat: 288 mammalia are Asiatic, of which 186 are common to it and other countries; these, however, chiefly belong to the temperate zone.

Asia Minor is a district of transition from the fauna of Europe to that of Asia. There the chamois, the bouquetin, the brown bear, the wolf, fox, hare, and others, are mingled with the hyæna, the angora goat, which bears a valuable fleece, the argali or wild sheep, the white squirrel, peculiar deer; and even the Bengal royal tiger is sometimes on Mount Ararat, and is not uncommon in Azerbaijan and the mountains in Persia.

Arabia is inhabited by the hyæna, panther, jackal, wolf, and musk-deer. Antelopes and monkeys are found in Yemen and Aden. Most of these are also indigenous in Persia. The wild ass, a handsome, spirited animal of great speed, and so shy that it is scarcely possible to come near it, wanders in herds over the deserts in both countries. It is also indigenous in the Indian desert, and especially in the Run of Cutch: "the wilderness and the barren lands are his dwelling."

The table-lands and mountains which divide eastern Asia almost into polar and tropical zones, produce as great a distinction in the character of its indigenous fauna. The severity of the climate in Siberia renders the skins of its numerous fur-bearing animals more valuable. These are reindeer, elks, wolves, the large white bear, that lives among the ice on the Arctic shores, several other bears, the lynx, various kinds of martens and cats, the common, the blue, and the black fox, the ermine, and sable. The fur of these last is much esteemed, and is inferior only to that of the sea-otter, which inhabits the shores on both sides of the Northern Pacific.

With the exception of the jerboa, which burrows in sandy deserts, on the table-land and elsewhere, all the Asiatic species of gnawers are confined to Siberia. The most remarkable of these is the flying squirrel. The Altai Mountains teem with wild animals, besides many of those mentioned. There are large stags, sloths, some peculiar weazels, the argali, and the musmon, or wild sheep, the same with



that in Sardinia. The wild goat of the Alps is found in the Sayansk part of the chain ; the glutton and musk-goat in the Baikal ; and in Da-Ouria the red-deer and a peculiar antelope. The Bengal tiger and the felis-irbis, a species of panther, wander from the Celestial Mountains to the Altai chain and southern Siberia ; and the tiger is met with even on the banks of the Obi, and also in China, though in the northern regions it differs considerably from the same species in Bengal. The tapir, and many of the animals of the Indian Archipelago, are in the southern provinces of the Chinese empire ; but its fauna is little known. It is, however, probable that in the northern parts it resembles that of the Altai Mountains and Siberia. The animals of Japan have a strong analogy to those of Europe : many are identical, or slightly varied, as the badger, otter, mole, common fox, marten, and squirrel. On the other hand, a large species of bear in the island of Jezo is analogous to the grizzly bear in the rocky mountains of North America. A chamois in other parts of Japan is similar to the chamois montana of the same mountains ; and other animals native in Japan are the same with those in Sumatra ; so that its fauna is connected with that of very distant regions.

A few animals are peculiar to the high cold plains of the table-land of eastern Asia : the dzigguetai, a very fleet animal, resembling both the horse and the ass, is peculiar to these Tartarian steppes ; two species of antelopes inhabit the plains of Tibet, congregating in immense herds, with sentinels so vigilant that it is scarcely possible to approach them. The dzeran, or yellow goat, which is both swift and shy, and the handsome Tartar ox, are native in these wilds ; also the shawl-wool goat and the manul, from which the Angora cat, so much admired in Persia and Europe, is descended.

The ruminating animals of Asia are more numerous and more excellent than those of any other part of the world ; 64 species are native, and 46 of these exist there only. There are several species of wild oxen ; one in the Burmese empire, and on the mountains of north-eastern India, with spiral twisted horns. The buffalo is native in China, India, Borneo, and the Sunda Islands ; it is a large animal, formidable in a wild state, but domesticated universally in the East. It was introduced into Italy in the sixth century, and large herds now graze in the low marshy plains near the sea.



Various kinds of oxen have been domesticated in India time immemorial: the handsome Indian ox, with a hump on the shoulder, has been venerated by the Bramins for ages; the beautiful white silky tail of the domesticated Tartar ox, used in the East to drive away flies, was adopted as the Turkish standard; and the common Indian ox differs from all others in having great speed. Some other species of cattle have been tamed, and some are still wild in India, Java, and other Asiatic Islands. The Cashmere goat, which bears the shawl wool, is the most valuable of the endless varieties of goats and sheep of Asia; it is kept in large herds on the central table-land, on the northern declivities of the Himalaya, and in the upper regions of Bhotan, where the cold climate is congenial to it.

Twelve species of antelope and 20 of deer are peculiar to Asia, of which the musk-deer of the Himalaya is one; two species of antelopes have been mentioned as peculiar to the table-land, others are distributed in the islands.

Asia possesses eight native species of thick-skinned animals, including the elephant, horse, ass, camel, and dromedary, which have been domesticated from the time of the earliest scriptural records. The horse and camel are supposed to have existed wild in the plains of Central Asia, and the dromedary in Arabia; though now they are only known as domestic animals. The Arabian and Persian horses have acknowledged excellence and beauty, and from these our best European horses are descended; the African horse, which was taken to Spain by the Moors, is probably of the same race.

The elephant has long been a domestic animal in Asia, though it still roams wild in formidable herds through the forests and jungles at the foot of the Himalaya, in other parts of India, the Indo-Chinese peninsula, and the islands of Sumatra and Ceylon, where it seems to be of a different species from those that are tame; the hunting elephant is esteemed the most noble. A rhinoceros with one horn is native on the continent.

There are 60 genera of Asiatic carnivorous animals, of which the royal tiger is the handsomest and the most formidable, its favourite habitation is in the jungles of Hindostan, though it wanders nearly to the limit of perpetual snow in the Himalaya, to the Persian and Armenian mountains, to



Siberia and China. Leopards and panthers are common, and there is a maneless lion in Guzerat: the chitta, used in hunting, is the only one of the tigers capable of being tamed. The hyæna is found everywhere, excepting the Birman empire, in which there are neither wolves, hyænas, foxes, nor jackals. There are four species of carnivorous bears in India; that of Nepaul has valuable fur: the wild boar, hog, and dogs of endless variety, abound.

Toothless animals have only two representatives in India; which, however, differ from all others except the African, in being covered with imbricated scales, which they can erect at pleasure.

The Indian Archipelago and the Indo-Chinese peninsula form a zoological province of a very peculiar nature, being allied to the faunas of India, Australia, and South America, yet having animals exclusively its own. Some groups of the islands have several animals in common, either identical, or with slight variations, that are altogether wanting in other islands, which, in their turn, have creatures of their own. Many species are common to the Archipelago and the neighbouring parts of the continent, or even to China, Bengal, Hindostan, and Ceylon. Flying quadrupeds are a distinguishing feature of this archipelago, though they do not absolutely fly, but, by an extension of the skin of their sides to their legs, they take long leaps. Nocturnal flying squirrels, of several species, are common to the Malayan peninsula and the Sunda Islands, especially Java: and three species of flying lemurs inhabit Sunda, Malacca, and the Pelew Islands. Besides these, there are the frugivorous bats, which really fly, and differ from bats in other countries in living upon vegetable food.

A hundred and eighty species of the ape and monkey tribe are entirely Asiatic: monkeys are found only on the coast of India, Cochin-China, and the Sunda Islands; the long-armed apes or gibbons are in the Sunda Islands and the Malayan peninsula; and the pongos or orang-outang are natives of Sumatra and Borneo. The simayang, a very large ape of Sumatra and Bencoolen, goes in large troops, following a leader, and makes a howling noise at sunrise and sunset that is heard miles off. Sumatra and Borneo are the peculiar abode of the orang-outang, which in the Malay language means the "man of the woods," and of all its kind, ex-



cept perhaps the chimpanzee of Africa and the kahau of the Malayan peninsula, approaches nearest to man. It has never spread over the islands it inhabits, though there seems to be nothing to prevent it, but it finds all that is necessary within a limited district. The orang-outang and the long-armed apes have extraordinary muscular strength, and swing from tree to tree by their arms.

The Malays have given the name of orang or man to the whole tribe, on account of their intelligence as well as their form.

A two-horned rhinoceros is peculiar to Java, of a different species from the African, also the felis macrocelis, and a very large bear; there are only two species of squirrels in Java, which is remarkable, as the Sunda Islands are rich in them. The royal tiger of India and the elephant are found only in Sumatra, and the babi-roussa or hog-deer lives in Borneo; but these two islands have many quadrupeds in common, as a leopard, the one-horned rhinoceros, the black antelope, some graceful miniature creatures of the deer kind, the tapir bicolor, also found in Malacca and India, besides a wild boar, an inhabitant of all the marshy forests from Borneo to New Guinea. In the larger islands deer abound, from the size of a rabbit to that of the elk.

The anoa, a ruminating animal about the size of a sheep, and in appearance something between the buffalo and antelope, shy and fierce, goes in herds in the mountains of Celebes, where many forms of animals strangers to the Sunda Islands begin to appear, as some sorts of phalangers, or pouched quadrupeds. These new forms become more numerous in the Moluccas, which are inhabited by flying phalangers and other pouched animals, with scaly tails. In New Guinea there are kangaroos, the spotted phalanger, the pelandoe, the New Guinea hog, and the Papua dog, said to be the origin of all the native dogs in Australia and Oceania, wild or tame.

The fauna of the Philippine Islands is analogous to that in the Sunda Islands. They have several quadrupeds in common with India and Ceylon, but there are others which probably are not found in these localities.



## AFRICAN QUADRUPEDS.

The opposite extremes of aridity and moisture in the African continent have had great influence in the nature and distribution of its animals ; and since by far the greater part consists of plains utterly barren or covered by temporary verdure, and watered by inconstant streams that flow only a few months in the year, fleet animals, fitted to live on arid plains, are far more abundant than those that require rich vegetation and much water. The latter are chiefly confined to the intertropical coasts, and especially to the large jungles and deep forests at the northern declivity of the table-land, where several genera and many species exist that are not found elsewhere. Africa has a fauna in many respects insulated from that of every other part of the globe ; for although about 100 of its quadrupeds are common to other countries, there are 250 species its own. Several of these animals, especially the larger kinds, are distributed over the whole table-land from the Cape of Good Hope to the highlands of Abyssinia and Senegambia without the smallest variety, and many are slightly modified in colour and size. Ruminating animals are very numerous, though few have been domesticated : of these the ox of Abyssinia and Bornou is remarkable from the extraordinary size of its horns, which are sometimes two feet in circumference at the root ; and the Galla ox of Abyssinia has horns four feet long. There are many African species of buffaloes : that at the Cape of Good Hope is a large, fierce animal, wandering in herds in every part of the country, even to Abyssinia : the flesh of the whole race is tainted with the odour of musk. The African sheep and goats, of which there are many varieties, differ from those of other countries ; the wool of all is coarse, except that of the Merino sheep, said to have been introduced into Spain by the Moors from Morocco.

No country has produced a ruminating animal similar, or even analogous, to the giraffe, or camelopard, which ranges widely over South Africa from the northern banks of the Gareep, or Orange River, to the Great Desert. It is a gentle, timid animal, which has been seen in troops of 100. The earliest record we have of it is, that it graced the triumph of a Roman emperor.



Africa may truly be said to be the land of the antelope, which is found in every part of it, though chiefly on the table-land. Different species have their peculiar localities, while others are widely dispersed, sometimes with and sometimes without any sensible variety of size or colour. The greater number are inhabitants of the plains, while a few affect the forests. Sixty species have been described, of which at least 26 are found at the Cape of Good Hope and in the adjacent countries. They are of every size, from the pigmy antelope not larger than a hare, to the eland, which is larger than a calf. Timidity is the universal character of the race. Many are gregarious; and the number in a herd is far too great even to guess at. Like all animals that feed in groups, they have sentinels; and they are the easy prey of so many carnivorous animals, that their safety requires the precaution. At the head of their enemies is the lion, who lurks among the tall reeds at the fountain, to seize them when they come to drink. They are graceful in their motions, especially the spring-buck, which goes in a compact troop; and in their march there is constantly some one which gathers its slender limbs together and bounds into the air.

Africa has only two species of deer, both belonging to the Atlas: one is the common fallow-deer of Europe.

The 38 species of rodentia, or gnawing quadrupeds, of this continent, live on the plains; and the greater part of them are leaping animals, as the gerboa capensis. Squirrels are rare, and all terrestrial.

There are five species of the horse kind in South Africa; of these the gaily-striped zebra, and the more sober-coloured quagga, of several species, wander in troops over the plains, often in company with ostriches. An alliance between creatures differing in nature and habits is not easily accounted for. The two-horned rhinoceros of Africa is different from that of Asia: there are certainly three, and probably five, species of these huge animals peculiar to the table-land. Dr. Smith saw 150 in one day near the 24th parallel of south latitude. The hippopotamus is exclusively African: multitudes inhabit the lakes and rivers in the intertropical and southern parts of the continent, and never change their abode. Elephants, differing in species from those in Asia, are so numerous, that 200 have been seen in a herd near Lake Chad. They are not now domesticated in Africa, and are hunted by



the natives for their tusks. A wild hog and the hyrax are among the thick-skinned quadrupeds of this country. The monkey tribe is found in all the hot parts of Africa : peculiar genera are allotted to particular districts. The family of guenons is found in no part of the world but the Cape of Good Hope, the coasts of Loango and Guinea ; the mandrills are peculiar to Guinea ; and of the cynocephalus, or blue-headed ape, one species inhabits Guinea, others the southern part of the table-land, and one is met with everywhere from Senaar to Cafraria. A very remarkable long-eared kind is found in Abyssinia ; the margot is in North Africa, and the chimpanzee inhabits the forests of South Africa from Cape Negro to the Gambia. Living in society like all apes and monkeys, which are eminently sociable, it is easily tamed, and very intelligent. Baron Humboldt observes that all apes resembling man have an expression of sadness ; that their gaiety diminishes as their intelligence increases.

Africa possesses the cat tribe in great variety and beauty ; lions, leopards, and panthers are numerous throughout the continent ; servals and viverrine cats are in the torrid districts ; and the lion of the Atlas is said to be the most formidable of all. In no country are foxes so abundant. Various species inhabit Nubia, Abyssinia, and the Cape of Good Hope. The corsac is peculiar to the Cape. The long-eared fox, the famel of Kordofan, and some others, are found in Africa only. There are also various species of dogs, the hyæna, and the jackal.

Two species of toothless animals are African—the long-tailed manis, and the aard-vark, or earth-hog ; both are covered with scales : they burrow in the ground, and feed on ants. Great flocks of a large migratory vampire-bat frequent the slave-coast. Altogether there are 26 species of African bats.

Multitudes of antelopes of various species, lions, leopards, panthers, hyænas, jackals, and some other carnivora, live in the oases of the great northern deserts ; gerboas and endless species of leaping gnawers, rats and mice, burrow in the ground. The dryness of the climate and soil keeps the coats of the animals clean and glossy ; and it has been observed that tawny and grey tints are the prevailing colours in the fauna of the North African deserts, not only in the birds and beasts, but in reptiles and insects. In consequence of the



continuous desert soil from North Africa through Arabia to Persia and India, many analogous species of animals exist in those countries; in some instances they are the same, or varieties of the same species, as antelopes, leopards, panthers, jackals, and hyænas.

The fauna on the eastern side of the great island of Madagascar is analogous to that of India; on the western side it resembles that of Africa, though, as far as it is known, it seems to be a distinct centre of animal life. It has no ruminating animals; and the monkey tribe is represented by the lemures, which are characteristic of this fauna. A frugivorous bat, the size of a common fowl, forms an article of food.

### AMERICAN QUADRUPEDS.

No species of animal has yet been extirpated in America, which is the richest zoological province, possessing 537 species of mammalia, of which 480 are its own, yet no country has contributed so little to the stock of domestic animals. With the exception of the llama (alpaca guanaco) and vicugna, the turkey, and perhaps some sheep and dogs, America has furnished no animal or bird serviceable to man, while it has received from Europe all its domestic animals and its civilized inhabitants.

Arctic America possesses almost all the valuable fur-bearing animals that are in Siberia; and they were very plentiful till the unsparing destruction of them has driven those yet remaining to the high latitudes, where the hunters that follow them are exposed to great hardships. Nearly 6,000,000 of skins were brought to England in one year. Of the large animals, the shaggy bison, the musk-ox, and the wapiti are peculiar. The musk-ox travels north to Parry's Islands; yet it never has been seen in Greenland or on the north-west coast of America. The range of the elk ends where the aspen and willow cease to grow. The rein-deer, living on lichens and mosses, wanders to the shores of the Polar Ocean: its southern limit in Europe is the Baltic, and in America the latitude of Quebec. The white bear, the largest and most formidable of his kind, inhabits the ice itself. The shaggy bison goes south to the Arkansas, and roams in herds of thou-



sands over the prairies of the Mississippi, and on both sides of the Rocky Mountains. A marten called the prairie-dog is universal.

There are at least eight species of American dogs, several of which are natives of the far north. The *logapus*, or *isatis*, native in Spitzbergen and Greenland, is found in all the Arctic regions of America and Asia, and in some of the Kurile Islands. Dogs are employed to draw sledges in Newfoundland and Canada; and the Esquimaux travel drawn by dogs as well as by rein-deer. The dogs are strong and docile. The Esquimaux dogs were mute, till they learned to bark from dogs in our discovery ships.

There are 13 species of the ruminating genus in North America, including the bison, the musk-ox of the Arctic regions, the big-horned sheep, and the goat of the Rocky Mountains; but of the thick-skinned tribe, so useful to man, there are only some tapirs, and a creature allied to the hog. The horse, now roaming wild in innumerable herds over the plains of South America, was unknown there till the Spanish conquest. Some of the fur-bearing animals of the north never pass  $65^{\circ}$  N. lat., and the rest live in the pine-forests of Canada. The quadrupeds of the temperate zone are also distributed in distinct groups: those of the state of New York, consisting of about 40 species, are different from those of the Arctic regions, and also from those of South Carolina and Georgia; while in Texas another assemblage of species prevails. Numerous species of gnawers are scattered over the northern continent, especially squirrels; the grey squirrel is in thousands; but the racoon, the coatimondi, and the kinkajou are all natives of the southern States. The opossum, a pouched animal of an order peculiarly Australian, is found in Virginia, and everywhere between the great Canadian lakes and Paraguay; and two other animals of that order live in Mexico. There is a porcupine in the United States and Canadian forests which climbs trees. The bats are different from those in Europe, and, excepting two, are very local. The grizzly bear of the Rocky Mountains is the largest and most ferocious of American bears. The prong-buck antelope is everywhere in the western parts of the continent, from  $53^{\circ}$  N. lat. to Mexico and California; it is swifter than the fleetest horse, and migrates to the south in winter. In California there are ounces, polecats, the fallow-deer, the



berenda (an animal peculiar to that country), and a deer of remarkable size and speed.

The high land of Mexico forms a very decided line of division between the fauna of North and that of South America; yet some North American animals are seen beyond it, particularly two of the bears, and one of the otters, which inhabits the continent from the icy ocean to beyond Brazil. On the other hand, the puma, jaguar, opossum, kinkajou, and peccari have crossed the barrier from South America to California and the United States.

In the varied and extensive regions of South America there are several centres of a peculiar fauna, according as the country is mountainous or level, covered with forest or grass, fertile or desert, but the mammalia are inferior in organization and size to those of the old world. The largest, most powerful, and perfect animals of this class are confined to the old continent. The South American quadrupeds are on a smaller scale, more feeble and more gentle; many of them, as the toothless group and the sloths, are of anomalous and less perfect structure than the rest of the animal creation, but the fauna of South America is so local and so peculiar, that the species of five of the terrestrial orders, which are indigenous there, are found nowhere else.

The monkey tribe are in myriads in the forests of tropical America and Brazil, but they never go north of the Isthmus of Darien, nor farther south than the Rio de la Plata. They differ widely from those in the old world, bearing less resemblance to the human race, but they are more gentle and lively, and, notwithstanding their agility, are often a prey to the vulture and puma. Some have no thumb, others have a versable thumb on hands and feet, and the thousands of sapajous have propensile tails, by which they suspend themselves and swing from bough to bough. These inhabitants of the woods are very noisy, especially the *argualis*, a large ape, whose howling is heard a mile off.

The forests are also inhabited by a family of the marsupial tribe, or animals with pouches, in which they carry their young; they are analogous to those which form the distinguishing feature of the Australian fauna, but of distinct genera and species. All the opossums and the yassacks of this family have thumbs on their hind feet, opposite to the toes, so that they can grasp; they are moreover distinguished



from the Australian family by a long prehensile tail, and by greater agility. The numerous tribe of sapajou monkeys, the ant-eaters, the kinkajou, and a species of porcupine, have also grasping tails, a property of many South American animals.

Five genera and 20 species of the toothless quadrupeds are characteristic of this continent, and exclusively confined to South America; they are the sloths, the ai, the armadilloes, chlamyphores, and ant-eaters. The animals of these five genera have very different habits: the sloths, as their name implies, are the most inactive of animals; while the armadillo, in its coat of mail, is in perpetual motion, and in speed can outrun a man. Several species of these animals are nocturnal, and burrow in the earth in the Pampas, Chili, and other places. The chlamyphores are also burrowing animals, peculiar to the province of Cuyo in La Plata, and they have the property of sitting upright. The ant-eater, larger than a Newfoundland dog, with shorter legs, defends itself against the jaguar with its powerful claws; it inhabits the swampy savannahs and damp forests from Colombia to Paraguay, and from the Atlantic to the foot of the Andes; its flesh, like that of some other American animals, has a flavour of musk. The little ant-eater has a prehensile tail, and lives on trees in the tropical forests, feeding on the larvæ of bees, wasps, honey, and ants; another of similar habits lives in Brazil and Guiana. The cat tribe in South America is beautiful and powerful: the puma, the lion of America, is found both in the mountains and the plains, in great numbers; so different are its habits in different places, that in Chili it is timid and flies from a dog; in Peru, it is bold, though it rarely attacks a man. The ounce, which inhabits the lower forests, kills Indians even near their huts. The jaguar, a large tiger, very abundant, is so ravenous that it has sprung upon Indians in a canoe; it is one of the few South American animals that cross the Isthmus of Darien, being found in California, on the territory of the Mississippi, and has been seen in Canada.

The vampire is a very large bat, much dreaded by the natives, because it enters their huts at night, and though it seldom attacks human beings, it wounds calves and small animals, which sometimes die from the loss of blood. The other three South American bats are harmless.



The only ruminating animals in South America are the alpacas, vicuñas, llamas, and guanacos; the three first are peculiar to the Andes, the fourth is also in the Pampas, and in all the southern temperate zone to Cape Horn; it is characteristic of the plains of Patagonia, where it is in large herds, and is easily tamed; to these may be added four species of deer. The gnawers of South America are peculiar and varied; more than 40 species of mice are native. The agouti represents our hares on these deserts, and the bizcacha is a burrowing animal, frequent in the pampas of Buenos Ayres. There is only one species of squirrel in the vast forests of South America. The guinea-pig, peccari, and caviés are South American; so is the beautiful chinchilla, the fur of which is so valuable. The only native dogs are a half-reclaimed breed, which the Indians have, and a dumb dog in Brazil.

It is very remarkable that in a country which has the most luxuriant vegetation there should not be one species of hollow-horned ruminants, as the ox, sheep, goat, or antelope; and it is still more extraordinary that the existing animals of South America, which are so nearly allied to the extinct inhabitants of the same soil, should be so inferior in size not only to them, but even to the living quadrupeds of South Africa, which is comparatively a desert. The quantity of vegetation in Britain at any one time exceeds the quantity on any equal area in the interior of Africa, ten-fold, yet Mr. Darwin has computed that the weight of 10 of the largest South African quadrupeds is 24 times greater than that of the same number of quadrupeds of South America; for in South America there is no animal the size of a cow, so that there is no relation between the bulk of the species and the vegetation of the countries they inhabit.

The largest animals indigenous in the West Indian Islands are the agouti, the racoon, the houtias, a native of the forests of Cuba; the didelphus carnivora and the kinkajou are common also to the continent; the kinkajou is a solitary instance of a carnivorous animal with a prehensile tail.



## AUSTRALIAN QUADRUPEDS.

Australia is not farther separated from the rest of the world by geographical position than by its productions. Its animals are creatures by themselves, of an entirely unusual type; few in species, and still fewer individually, if the vast extent of country be taken into consideration; and there has not been one large animal discovered. There are only 53 species of land quadrupeds in New Holland, and there is not a single example of the ruminating or thick-skinned animals, so useful to man, among them; there are no native horses, oxen, or sheep, yet all these thrive and multiply on the grassy steppes of the country, which seem to be so well suited to them. There are none of the monkey tribe, indeed they could not exist in a country where there is no fruit.

Of the 52 species of indigenous quadrupeds, 40 are found nowhere else, and 43 are marsupial or pouched animals, distinguished from all others by their young being nourished in the pouch till they are mature. Though all the members of this numerous family agree in this circumstance, they are dissimilar in appearance, internal structure, in their teeth and feet, consequently in their habits; two genera live on vegetable food, one set are gnawers and another toothless. The kangaroo and the kangaroo-rat walk on their hind legs, and go by bounds, aided by their strong tail; the rat holds its food in its hands like the squirrel; the opossum walks on all fours; the phalangers live on trees, and swing by their bushy tail, some burrow in the sand; the flying opossum or phalanger, peculiarly an Australian animal, lives on the leaves of the gum-tree; by expanding the skin of its sides it supports itself in the air in its leaps from bough to bough. Several of the genera come out at night only, a characteristic of many Australian animals.

The pouched tribe vary in size from that of a large dog to a mouse; the kangaroos, which are the largest, are easily domesticated, and are used for food by the natives. Some go in large herds in the mountains, others live in the plains; however, they have become scarce near the British colonies, and, with all other native animals, are likely to be extirpated. In Van Diemen's Land, they are less persecuted; several



species exist there. A wild dog in the woods, whose habits are ferocious, is the largest carnivorous animal in Australia.

The gnawing animals are aquatic and very peculiar, but the toothless animals of New Holland are quite extraordinary; of these there are two genera, the platypus ornithorhynchus, or duck-billed mole, and the echidna: they are the link that connects the edentata with the pouched tribe. The duck-billed mole is about 14 inches long, and covered with thick brown fur; its head is similar to that of a quadruped, ending in a bill like that of a duck; it has short furry legs with half-webbed feet, and the hind feet are armed with sharp claws. The burrows it inhabits on the banks of rivers have two entrances, one above and the other below the level of the water, which it seldom leaves, feeding on insects and seeds in the mud.

The echidna is similar in structure to the platypus, but entirely different in external appearance, being covered with quills like the porcupine; it is also a burrowing animal, sleeps during winter, and lives on ants in summer.

A singular analogy exists between Australia and South America in this respect, that the living animals of the two countries are stamped with the type of their ancient geological inhabitants, while in England and elsewhere the difference between the existing and extinct generation of beings is most decided. Australia and South America seem still to retain some of those conditions that were peculiar to the most ancient eras. Thus each tribe of the innumerable families that inhabit the earth, the air, and the waters, has a limited sphere. How wonderful the quantity of life that now is, and the myriads of beings that have appeared and vanished. Dust has returned to dust through a long succession of ages, and has been continually remoulded into new forms of existence—not an atom has been annihilated: the fate of the vital spark that has animated it, with a vividness sometimes approaching to reason, is one of the deep mysteries of Providence.



## CHAPTER XXXI.

THE DISTRIBUTION, CONDITION, AND FUTURE PROSPECTS OF  
THE HUMAN RACE.

MORE than 860,000,000 of human beings are scattered over the face of the earth, of all nations and kindreds and tongues; and in all stages of civilization, from a high state of moral and intellectual culture, to savages but little above the animals that contend with them for the dominion of the deserts and forests through which they roam. This vast multitude is divided into nations and tribes, differing in external appearance, character, language, and religion. The manner in which they are distributed, the affinities of structure and language by which they are connected, and the effect that climate, food, and customs may have had in modifying their external form, or their moral and mental powers, are subjects of much more difficulty than the geographical dispersion of the lower classes, inasmuch as the immortal spirit is the chief agent in all that concerns the human race. The progress of the universal mind in past ages, its present state, and the future prospects of humanity, rouse the deep sympathies of our nature for the high but mysterious destiny of the myriads of beings yet to come, who, like ourselves, will be subject for a few brief years to the joys and sorrows of this transient state, and fellow-heirs of eternal life hereafter.

Notwithstanding the extreme diversity, personal and mental, in mankind, anatomists have found that there are no specific differences—that the hideous Esquimaux, the refined and intellectual Circassian, the thick-lipped swarthy Negro, and the fair blue-eyed Scandinavian, are mere varieties of the same species. The human race forms five great classes or families, marked by strong distinctive characters. Many nations are included in each, distinguished from one another by different languages, manners, and mental qualities, yet



bearing such a resemblance in structure and physiognomy as to justify a classification apparently anomalous.

The Circassian group of nations, which includes the handsomest and most intellectual portion of mankind, inhabit all Europe, except Lapland, Finland, and Hungary; they occupy North Africa as far as the 20th parallel of north latitude, Arabia, Asia Minor, Persia, the Himalaya to the Brahmapootra, all India between these mountains and the ocean, and the United States of North America. These nations are remarkable for a beautifully-shaped small head, regular features, fine hair, and symmetrical form. The Greeks, Georgians, and Circassians are models of perfection in form, especially the last, assumed as the type of this class of mankind; of which it is evident that colour is not a characteristic, since they are of all shades, from the fair and florid to the clear dark brown and almost black. This family of nations has always been, and still is, the most civilized portion of the human race. The inhabitants of Hindostan, the Egyptians, Arabians, Greeks, and Romans, were in ancient times what the European nations are now. The cause of this remarkable development of mental power is no doubt natural disposition, for the difference in the capabilities of nations seems to be as great as that of individuals. The origin of spontaneous civilization and superiority may generally be traced to the talent of some master-spirit gaining an ascendancy over his countrymen. Natural causes have also combined with mental—mildness of climate, fertility of soil; rivers and inland seas, by affording facility of intercourse, favoured enterprise and commerce; and the double-river systems in Asia brought distant nations together, and softened those hostile antipathies which separate people, multiply languages, and reduce all to barbarism. The genius of this family of nations has led them to profit by these natural advantages, whereas the American Indians are at this day wandering as barbarous hordes in one of the finest countries in the world. An original similarity or even identity of many of the spoken languages, may be adverted to as facilitating communication and mental improvement among the Circassian class in very ancient times.

The Mongol-Tartar family forms the second group of nations. They occupy all Asia north of the Persian tableland and of the Himalaya, the whole of eastern Asia from the



Brahmapootra to Behring's Straits, together with the Arctic regions of North America south to Labrador. This family includes the Tourkomans, Mongol and Tartar tribes, the Chinese, Indo-Chinese, Japanese, and Esquimaux; and the Hungarians in the very heart of Europe. These nations are distinguished by broad skulls and high cheek-bones, with small black eyes obliquely set, long black hair, and a yellow or sallow olive complexion; some are good looking, and many are well made. A portion of this family is capable of high culture, especially the Chinese, the most civilized nation of eastern Asia, although they never have attained the excellence of the Caucasian group, probably from their exclusive social system, which has separated them from the rest of mankind and kept them stationary for ages; the peculiarity and difficulty of their language have also tended to insulate them. The Kalmuks, who lead a pastoral, wandering life, on the steppes of Central Asia, and the Esquimaux, have wider domains than any other of this set of nations. The Kalmuks are rather a handsome people, and like all who lead a savage life, have acute senses of seeing and hearing. The inhabitants of Finland and Lapland are nearly allied to the Esquimaux, who occupy all the high latitudes of both continents—a diminutive race, equally ugly in face and form.

Malayan nations occupy the Indian Archipelago, New Zealand, Chatham Island, the Society group, and several other of the Polynesian islands, together with the Philippines and Formosa. They are very dark, with lank coarse black hair, flat face, and obliquely set eyes. Endowed with great activity and ingenuity, they are mild and gentle, and far advanced in the arts of social life, in some places; in others, ferocious and revengeful, daring and predatory: and, from their maritime position and skill, they are a migratory race. Several branches of this class of nations had a very early indigenous civilization, with an original literature in peculiar characters of their own.

The Ethiopian nations are widely dispersed; they occupy all Africa south of the Great Desert, half of Madagascar, the continent of Australia, Mindanao, Gilolo, the high lands of Borneo, Sumbawa, Timor, and New Ireland. The distinguishing characters of this group are a black complexion, black woolly or frizzled hair, thick lips, projecting jaws,



high cheek-bones, and large prominent eyes. A great variety, however, exists in this jetty race. Some are handsome both in face and figure, especially in Ethiopia; and even in Western Africa, where the negro tribes live, there are groups in which the distinctive characters are less exaggerated. This great family has not yet attained a high place among the nations, though by no means incapable of cultivation; and part of Ethiopia appears to have made considerable advances in civilization in very ancient times. But the formidable deserts, so extensive in some parts of the continent, and the unwholesome climate in others, have cut off the intercourse with civilized nations; and, unfortunately, the infamous traffic in slaves, to the disgrace of Christianity, has made the nations of tropical Africa more barbarous than they were before; while, on the contrary, the Foulahs and other tribes, who were converts to Mohammedanism 400 years ago, have now large commercial towns, cultivated grounds, and schools. The Australians and Papuans, who inhabit the Eastern islands mentioned, are the most degraded of this dark race, and indeed of all mankind.

The American race, who occupy the whole of that continent from 62° N. lat. to the Straits of Magellan, are almost all of a reddish-brown or copper colour, with long black hair, deep-set black eyes, aquiline nose, and often of handsome slender forms. In North America they live by hunting, are averse to agriculture, slow in acquiring knowledge, but extremely acute, brave, and fond of war; and though revengeful, are capable of generosity and gratitude. In South America many are half civilized, but a greater number are still in a state of utter barbarism. In a family so widely scattered, great diversity of character prevails; yet throughout the whole there is a similarity of manners and habits, which has resisted all the effects of time and climate.

Each of these five groups of nations, spread over vast regions, is accounted one family; and if they are so by physical structure, they are still more so by language, which expresses the universal mind of a people, modified by external circumstances, of which none have a greater influence than the geographical features of the country they inhabit, and that influence is deepest in the early stages of society. The remnants of ancient poetry in the south of Scotland partake of the gentle and pastoral character of the country;



while Celtic verse, and even the spoken language of the Highlander, are full of the poetical images of war and stern mountain scenery. As civilization advances, and man becomes more intellectual, the language keeps pace in the progress. New words and new expressions are added, as new ideas occur and new things are invented, till at last language itself becomes a study, is refined, and perfected by the introduction of general terms. The art of printing perpetuates a tongue, and great authors immortalize it; yet language is ever changing to a certain degree, though it never loses traces of its origin. Chaucer and Spenser have become obscure; Shakspeare requires a glossary for the modern reader; and in the few years that the United States of America have existed as an independent nation the speech has deviated from the mother tongue. When a nation degenerates, it is split by jealousy and war into tribes, each of which in process of time acquires a peculiar idiom, and thus the number of dialects is increased, though they still retain a similarity; whereas when masses of mankind are united into great political bodies, their languages by degrees assimilate to one common tongue, which retains traces of all to the latest ages. The form of the dialects now spoken by some savage tribes, as the North American Indians, bears the marks of a once higher state of civilization.

More than 2000 languages are spoken, but few are independent; some are connected by words having the same meaning, some by grammatical structure, others by both; indeed the permanency of language is so great, that neither ages of conquest nor mixing with other nations have obliterated the native idiom of a people. The French, Spanish, and German retain traces of the common language spoken before the Roman conquest, and the Celtic tongue still exists in the British Islands.

By a comparison of their dialects, nations far apart, and differing in every other respect, are discovered to have sprung from a common, though remote origin. Thus all the numerous languages spoken by the American Indians, or red men, are similar in grammatical structure: an intimate analogy exists in the languages of the Esquimaux nations, who inhabit the Arctic regions of both continents. Dialects of one tongue are spoken throughout North Africa, as far south as the oasis of Siwah on the east and the Canary Islands on



the west. Another group of cognate idioms is common to the inhabitants of equatorial Africa ; while all the southern part of the continent is inhabited by people whose languages are connected. The monosyllabic speech of the Chinese and Indo-Chinese shows that they are the same people, and all the insular nations of the Pacific derived their dialects from some tribes on the continent of India and the Indian Archipelago.

The Persian, Arabic, Greek, Latin, German, and Celtic tongues are connected by grammatical structure, and words expressive of the same objects and feelings with the Sanscrit, or sacred language of India ; consequently the nations inhabiting the British Islands and these extensive districts of the Continent must have had the same origin.

The two methods of classing mankind that have been mentioned do not perfectly agree, nor does either of them include the whole, but an approximation is all that can be attained in so complicated a subject.

It is no difficult matter to see how changes may occur in speech, but no circumstance in the natural world is more inexplicable than the diversity of form and colour in the human race. It had already begun in the Antediluvian world, for "there were giants in the land in those days." No direct mention is made of colour at that time, unless the mark set upon Cain, "lest any one finding him should kill him," may allude to it. Perhaps, also, it may be inferred that black people dwelt in Ethiopia, or the land of Cush, which means black in the Hebrew tongue. At all events, the difference now existing must have arisen after the flood, consequently all must have originated with Noah, whose wife, or the wives of his sons, may have been of different colours for aught we know.

Many instances have occurred in modern times of albinos and red-haired individuals having been born of black parents, and these have transmitted their peculiarities to their descendants for several generations ; but it may be doubted whether pure-blooded white people have ever had perfectly black offspring. The varieties are much more likely to have arisen from the effects of climate, food, customs, and civilization upon migratory groups of mankind, and of such a few instances have occurred in historical times, limited, however, to small numbers and particular spots ; but the



great mass of nations had received their distinctive characters at a very early period. The permanency of type is one of the most striking circumstances, and shows the immense length of time necessary to produce a change in national structure and colour. A nation of Ethiopians existed 3450 years ago, which emigrated from a remote country and settled near Egypt, and there must have been black people before the age of Solomon, otherwise he would not have alluded to colour even poetically. Besides, the national appearance of the Ethiopians, Persians, and Jews has not varied for more than 3000 years, as appears from the ancient Egyptian paintings in the tomb of Rhameses the Great, discovered at Thebes by Belzoni, in which the countenance of the modern Ethiopian and Persian can be readily recognised, and the Jewish features and colour are identical with those of the Israelites daily met with in London. As there is no instance of a new variety of mankind having been established as a nation since the Christian era, there must either have been a greater energy in the causes of change before that era, or, brief as man's span on earth has been, a wrong estimate of time antecedent to the Christian period must have made it shorter.

Darkness of complexion has been attributed to the sun's power from the age of Solomon to this day. "Look not upon me, because I am black, because the sun hath looked upon me:" and there cannot be a doubt, that to a certain degree the opinion is well founded. The invisible rays in the solar beams, which change vegetable colour, and have been employed with such remarkable effect in the Daguerreotype, act upon every substance on which they fall, producing mysterious and wonderful changes in their molecular state, man not excepted.

Other causes must have been combined to occasion all the varieties we now see, otherwise every nation between the tropics would be of the same hue; whereas the sooty negro inhabits equatorial Africa, the red man equinoctial America, and both are mixed with fairer tribes. In Asia, the Rohillas, a fair race, inhabit the plains south of the Ganges; the Bengalee and the mountaineers of Nepaul are dark, and the Mahrattas are yellow. Even supposing that diversity of colour is owing to the sun's rays only, it is scarcely possible to attribute the thick lips, the woolly hair,



and the entire difference of form, extending even to the very bones and skull, to any thing but a variety of concurring circumstances, not omitting the invisible influence of electricity, which pervades every part of the earth and air, and possibly terrestrial magnetism.

The flexibility of man's constitution enables him to live in every climate from the equator to the ever-frozen coasts of Nova Zembla and Spitzbergen and that chiefly by his capability of bearing the extremest changes of temperature and diet, which are probably the principal causes of the variety in his form. It has already been mentioned that oxygen is inhaled with the atmospheric air, and also taken in by the pores in the skin; part of it combines chemically with the carbon of the food, and is expired in the form of carbonic-acid gas and water; that chemical action is the cause of vital force and heat in man and animals. The quantity of food must be in exact proportion to the quantity of oxygen inhaled, otherwise disease and loss of strength would follow. Since cold air is incessantly carrying off warmth from the skin, more exercise is requisite in winter than in summer, in cold climates than in warm; consequently more carbon is necessary in the former than in the latter, in order to maintain the chemical action that generates heat, and to ward off the destructive effects of the oxygen, which incessantly strives to consume the body. Animal food, wine and spirits contain many times more carbon than fruit and vegetables, therefore animal food is much more necessary in a cold than in a hot climate. The Esquimaux, who lives by the chase, and eats 10 or 12 pounds weight of meat and fat in 24 hours, finds it not more than enough to keep up his strength and animal heat; while the indolent inhabitant of Bengal is sufficiently supplied with both by his rice diet. Clothing and warmth make the necessity for exercise and food much less, by diminishing the waste of animal heat. Hunger and cold united soon consume the body, because it loses its power of resisting the action of the oxygen, which consumes part of our substance when food is wanting. Hence nations inhabiting warm climates have no great merit in being abstemious, nor are those committing an excess who live more freely in the colder countries. The arrangement of Divine Wisdom is to be admired as much in this as in all other things, for if man had only been capable of living



on vegetable food, he never could have had a permanent residence beyond the latitude where corn ripens. The Esquimaux and all the inhabitants of the very high latitudes of both continents live entirely on fish and animal food.

A nation or tribe driven by war, or any other cause, from a warm to a cold country, or the contrary, would be forced to change their food both as to quantity and quality, which in the lapse of ages might produce an alteration in the external form and internal structure. The probability is still greater, if the entire change that a few years produces in the matter of the human frame be considered. At every instant during life, with every motion, voluntary and involuntary, with every thought and exercise of the brain, a portion of our substance becomes dead, separates from the living part, combines with some of the inhaled oxygen, and is removed. By this process it is supposed that the whole body is renewed every seven years: individuality, therefore, depends on the spirit, which retains its identity during all the changes of its earthly house, and sometimes even acts independently of it. When sleep is restoring exhausted nature, the spirit is often awake and active, crowding the events of years into a few seconds, and, by its unconsciousness of time, anticipates eternity. Every change of food, climate, and mental excitement must have their influence on the reproduction of the mortal frame; and thus a thousand causes may co-operate to alter whole races of mankind placed under new circumstances, time being granted.

The difference between the effects of manual labour and the efforts of the brain appears in the intellectual countenance of the educated man, compared with that of the peasant, though he also is occasionally stamped with nature's own nobility. The most savage people are also the ugliest. Their countenance is deformed by violent unsubdued passions, anxiety, and suffering. Deep sensibility gives a beautiful and varied expression, but every strong emotion is unfavourable to perfect regularity of feature; and of that the ancient Greeks were well aware when they gave that calmness of expression and repose to their unrivalled statues. The refining effects of high culture, and, above all, the Christian religion, by subduing the evil passions, and encouraging the good, are more than any thing calculated to improve even the external appearance. The countenance, though perhaps



of less regular form, becomes expressive of the amiable and benevolent feelings of the heart, the most captivating and lasting of all beauty.

Thus an infinite assemblage of causes may be assigned as having produced the endless varieties in the human race; but the fact remains an inscrutable mystery not to be explained, more than why twin-brothers are not exactly alike. But amidst all the physical vicissitudes man has undergone, the species remains permanent; and let those who think that the difference in the species of animals and vegetables arises from diversity of conditions, consider that no circumstances whatever can degrade the form of man to that of the monkey, or elevate the monkey to the form of man.

Animals and vegetables, being the sources of man's sustenance, have had the chief influence on his destiny and location, and have induced him to settle in those parts of the world where he could procure them in greatest abundance. Wherever the chase or the spontaneous productions of the earth supply him with food, he is completely savage, and only a degree further advanced where he plants the palm and banana; where grain is the principal food, industry and intelligence are most perfectly developed, as in the temperate zone. On that account, the centres of civilization have generally been determined, not by hot, but genial climate, fertile soil, by the vicinity of the sea-coast or great rivers, affording the means of fishing and transport, which last has been one of the chief causes of the superiority of Europe and southern Asia. The mineral treasures of the earth have been the means of assembling great masses of men in Siberia and the table-land of the Andes, and have given rise to many great cities, both in England and North America. Nations inhabiting elevated table-lands and high ungenial latitudes have been driven there by war, or obliged to wander from countries where the population exceeded the means of living—a cause to which both language and tradition bear testimony. The belief in a future state, so universal, and shown by respect for the dead, has no doubt been transmitted from nation to nation. The American Indians, driven from their hunting-grounds, still make pilgrimages to the tombs of their fathers; and these tribes alone, of all civilized mankind, worship the Great Spirit as the invisible God and Father of all—a degree of abstract refinement which could hardly



have sprung up spontaneously among a rude people, and must have been transmitted from races who held the Jewish faith.

The influence of external circumstances on man is not greater than his influence on the material world. It is true, he cannot create power; but he dexterously avails himself of the powers of nature to subdue nature. Air, fire, water, steam, gravitation, his own muscular strength and that of animals, have been the instruments by which he has converted the desert into a garden, drained marshes, turned the course of rivers, cut canals, made roads, cleared away forests in one country, and planted them in another. By these works he has altered the climate, changed the course of local winds, increased or diminished the quantity of rain, and softened the rigour of the seasons. In the time of Strabo, the cold in France was so intense, that it was thought impossible to ripen grapes north of the Cevennes; and the Rhine and Danube were every winter covered with ice thick enough to bear any weight. Man's influence on vegetation has been immense, but the most important changes were produced in the antediluvian ages of the world. Cain was a tiller of the ground. The olive, the vine, and the fig-tree have been cultivated time immemorial: wheat, rice, and barley have been so long in an artificial state that their origin is unknown: even maize, which is a Mexican plant, was in use among the American tribes before the Spanish conquest; and tobacco was already used by them to allay the pangs of hunger, to which those who depend upon the chase for food must be exposed. Most of the ordinary culinary vegetables have been known for ages; and it is singular that in these days, when our gardens are adorned with innumerable native plants in a cultivated state, no new grain, vegetable, or fruit has been reclaimed: the old have been produced in infinite variety, and many brought from foreign countries; yet there must exist many plants capable of cultivation, as unpromising in their wild state as the turnip or carrot.

Some families of plants are more susceptible of improvement than others, and, like man himself, can bear almost any climate. One kind of wheat grows to  $62^{\circ}$  N. lat.; rye and barley succeed still farther north; and few countries are absolutely without grass. The cruciform tribe abounds in useful plants; indeed, that family, together with the solanum,



the papilionaceous, and umbelliferous tribes, furnish most of our vegetables. Many plants, like animals, are of but one colour in their wild state, and their blossoms are single. Art has introduced that variety we now see in the same species; and by changing the anthers of the wild flower into petals, has produced double blossoms: by art, too, many plants of warm countries have been naturalized in colder. Few useful plants have beautiful blossoms; but if utility were the only object, of what pleasure should we be deprived? Refinement is not altogether wanting in the inmates of a cottage covered with roses and honeysuckle; and the little garden, cultivated amidst a life of toil, tells of a peaceful home.

Among the objects which tend to the improvement of our race, the flower-garden and the park, adorned with native and foreign trees, have no small share: they are the greatest ornaments of the British Islands; and the love of a country life, which is so strong a passion, is chiefly owing to the law of primogeniture, by which the head of a family is secured in the possession and transmission of his undivided estate, and therefore each generation takes a pride and pleasure in adorning the home of their forefathers.

Animals yield more readily to man's influence than vegetables; but certain classes have a greater flexibility of disposition and structure than others. Those only are capable of being perfectly reclaimed that have a natural tendency for it, without which man's endeavours would be unavailing. This predisposition is greatest in animals that are gregarious and follow a leader, which elephants, dogs, horses, and cattle do in their wild state; but even among these some species are refractory, as the buffalo, which can only be regarded as half reclaimed. The canine tribe, on the contrary, are capable of the greatest attachment; not the dog only, man's faithful companion, but even the wolf, and especially the hyæna, generally believed to be so ferocious. After an absence of many months, a hyæna recognised the voice of a friend of the author before he came in sight, and on seeing him it showed the greatest joy, lay down like a dog and licked his hands. He had been kind to it on the voyage from India, and no animal forgets kindness, which is the surest way of reclaiming them. There cannot be a greater mistake than the harsh and cruel means by which dogs and



horses are too commonly trained ; but it is long before man learns that his power is mental, and that it is his intellect alone that has given him dominion over the earth and its inhabitants, many of which far surpass him in physical strength. The useful animals were reclaimed by the early inhabitants of Asia, and little has been left for modern nations but the improvement of the species, and in that they have been very successful. The variety of horses, dogs, oxen, and sheep is beyond number. The form, colour, and even the disposition, may be materially altered, and the habits engrafted are transmitted to the offspring, as instinctive properties independent of education. Domestic fowls go in flocks in their native woods, when wild. There are, however, instances of solitary birds being tamed to an extraordinary degree, as the raven, one of the most sagacious.

Man's necessities and pleasures have been the cause of great changes in the animal creation, but his destructive propensity still greater. Animals are intended for our use, and field-sports are advantageous by encouraging a daring and active spirit in young men ; but the utter destruction of some races, in order to protect those destined for his amusement, is too selfish. Animals soon acquire an instinctive dread of man, which becomes hereditary. In newly discovered uninhabited countries, birds and beasts are so tame as to allow themselves to be taken. Whales scarcely got out of the way of the ships that first navigated the Arctic Ocean, but they now have a dread of the common enemy. Many land animals and birds are vanishing before the advance of civilization. Sea-fowl and birds of passage are not likely to be extinguished. The inaccessible cliffs of the Himalaya and the Andes will afford a refuge to the eagle and the condor ; but the time will come when the mighty forests of the Amazons and Orinoco will disappear with the myriads of their joyous inhabitants. The lion, the tiger, and the elephant will be known only by ancient records. Man, the lord of the creation, will extirpate the noble creatures of the earth, but he himself will ever be the slave of the canker-worm and the fly. Cultivation may lessen the scourge of the insect tribe, but God's great army will ever from time to time appear suddenly, no one knows from whence ; and the locust will come from the desert, and destroy the fairest prospects of the harvest.



Though the unreclaimed portion of the animal creation is falling before the progress of improvement, yet man has been both the voluntary and the involuntary cause of the introduction of new animals and plants into countries in which they were not native. The Spanish conquerors little thought that the descendants of the horses and cattle they allowed to run wild would resume the original character of their species, and roam in hundreds of thousands over the savannahs of South America. Wherever man is, civilized or savage, there also is the dog ; but he too has in some places resumed his native state and habits, and hunts in packs. Domestic animals, grain, fruit, vegetables, and the weeds that grow with them, have been conveyed by colonists to all settlements. Birds and insects follow certain plants into countries in which they were never seen before. Even the inhabitants of the waters change their abode in consequence of the influence of man. Fish, natives of the rivers on the coast of the Mexican Gulf, have migrated by the canals to the heart of North America ; and the *mytilus polymorphus*, a shell-fish brought to the London docks in the timbers of ships from the brackish waters of the Black Sea and its tributary streams, has spread into the interior of England by the Croydon and other canals.

The influence of man on man is a power of the highest order, far surpassing that which he possesses over inanimate or animal nature ; and at no time did the mental superiority of the cultivated races produce such changes as they do at present. In civilized society, the number of people in the course of time exceeds the means of sustenance, which compels some to emigrate ; others are induced by a spirit of enterprise to go to new countries, some for the love of gain, others to fly from oppression.

The discovery of the new world opened a wide field for emigration. Spain and Portugal, the first to avail themselves of it, acquired dominion over some of the finest parts of South America, which they have maintained, till lately a change of times has rendered their colonies independent states. Liberal opinions have spread into the interior of the continent in proportion to the facility of communication with the cities on the coasts, from whence European ideas are disseminated. Of this Venezuela is an instance, where civilization and prosperity have advanced more rapidly than in the



southern parts of Colombia, where the Andes are higher, and the distance from the Atlantic greater. Civilization has been impeded in many of the smaller states by war and those broils inevitable among people unaccustomed to free institutions; and Brazil would have been farther advanced but for slavery, that stain on the human race, which corrupts the master as much as it debases the slave.

Some of the native South American tribes have spontaneously made considerable progress in civilization in modern times; others have been benefited by the Spanish and Portuguese colonists; and many tribes have been brought into subjection by the Jesuits, who have instructed them in some of the arts of social life: but these Indians are not more religious than their neighbours; and, from restraint, they have lost vigour of character without improving in intellect, so that they are now either stationary or retrograde. But extensive regions are still the abode of men in the lowest state of barbarism; almost all those inhabiting the silvas of the Orinoco, Amazons, and Uruguay are cannibals.

The arrival of the colonists in North America sealed the fate of the red man. The inhabitants of the Union, too late awakened to the just claims of the ancient proprietors of the land, have recently, but vainly, attempted to save the remnant. The white man, like an irresistible torrent, has already reached the centre of the continent; and the native tribes now retreat towards the far west, and will continue to retreat till the Pacific Ocean arrests them, and the animals on their hunting-grounds are exterminated. The almost universal dislike the Indian has shown for the arts of peace has been one of the principal causes of his decline, although the Cherokee tribe, which has lately removed to the west of the Mississippi, is a remarkable exception: the greater number of them are industrious planters or mechanics; they have a republican government, and publish a newspaper in their own language, in a character lately invented by one of that nation.

No part of the world has been the scene of greater iniquity than the West Indian Islands, and that perpetrated by the most enlightened nations of Europe. The native race has long been swept away by the stranger, and a new people, cruelly torn from their homes, have been made the slaves of hard task-masters. If the odious participation in this guilt



has been a stain on the British name, the abolition of slavery by the universal acclamation of the nation will ever form one of the brightest pages in their history, so full of glory; nor will it be the less so that justice was combined with mercy, by the millions granted to indemnify the proprietors. It is deeply to be lamented that our brethren on the other side of the Atlantic have not followed the example of their fatherland; but in limited monarchies the voice of the people is listened to, while republican governments are more apt to become its slave. The northern States have nobly declared every man free who sets his foot on their territory; and the time will come when the southern States will sacrifice interest to justice and mercy.

It seems to be the design of Providence to supplant the savage by civilized man in the continent of Australia as well as in North America, though every effort has been made to prevent the extinction of the natives. Most of the tribes in that continent are as low in the rank of mankind as the cannibal Fuegians whom Captain Fitzroy so generously but ineffectually attempted to tame. Some of the New Hollanders are faithful servants for a time; but they almost always return to their former habits, though truly miserable in a country where the means of existence are so scanty. Animals and birds are very scarce; and there is no fruit or vegetable for the sustenance of man.

Slavery has been a greater impediment to the improvement of the nations of Africa than even the physical disadvantages of the country, the great arid deserts and unwholesome coasts. A spontaneous civilization has arisen in various parts of southern and tropical Africa, in which there has been considerable progress in agriculture and commerce; but civilized man has been a scourge on the Atlantic coast, which has extended its influence into the heart of the continent, by the encouragement it has given to warfare among the natives for the capture of slaves, and by the introduction of European vices, unredeemed by Christian virtues. Now that France and England have united in the suppression of this odious traffic, some hope may be entertained that their colonies may be beneficial to the natives, and that other nations may follow their example, in which, however, they have been anticipated by three Mohammedan sovereigns. The Sultan has abolished the slave-market in Constanti-



nople ; Ibrahim Pasha, on his return from France and England, gave freedom to his bondsmen in Egypt ; and the Bey of Tunis has abolished slavery in his dominions.

The French are zealous in improving the people in Algiers ; but the constant state of warfare in which they have been involved ever since their conquest, must render their success in civilizing the natives at least remote. And the inhabitants of those extensive and magnificent countries that have long been colonized by the Dutch, have made but little progress under their rule.

The British colony at the Cape of Good Hope has had considerable influence on the neighbouring rude nations, who begin to adopt more civilized habits. When Mr. Somerville visited Latakoo, the natives were scantily covered with skins, and they saw horses for the first time. Dr. Smith, who visited them twenty years afterwards, found the chief men mounted on horseback, wearing hats made of rushes, and an attempt to imitate European dress.

Colonization has nowhere produced such happy effects as among the amiable and cultivated inhabitants of India, who are sensible of the benefits they derive from the impartial administration of just and equal laws, the foundation of schools and colleges, and the extension of commerce.

All the causes of emigration have operated by turns on the inhabitants of Britain, and various circumstances have concurred to make their colonies permanent. In North America, that which not many years ago was a British colony has become a great independent nation, occupying a large portion of the continent. The Australian continent will in after ages be peopled by British nations, and will become a centre of civilization which will extend its influence to the uttermost islands of the Pacific. These splendid islands, possessing every advantage of climate and soil, with a population in many parts far advanced in the arts of civilized life, industry, and commerce, though in others savage, will in time come in for a share of the general improvement. The success that has attended the noble and unaided efforts of Mr. Brooke in Borneo, shows how much the influence of an active mind can effect.

The colonies on the continent of India are already centres from which the culture of Europe is spreading over the East.



Commerce has no less influence on mankind than colonization, with which it is intimately connected ; and the narrow limits of the British Islands have rendered it necessary for its inhabitants to exert their industry for their well-being. The riches of our mines in coal and metals, which produce a yearly income of 24,000,000*l.* sterling, is a principal cause of our manufacturing and commercial wealth ; but even with these natural advantages, more is due not only to the talents and enterprise, but to our high character for faith and honour.

Every country has its peculiar productions, and by an unrestrained interchange of the gifts of Providence the condition of all is improved. The exclusive jealousy with which commerce has hitherto been fettered, shows the length of time that is necessary to wear out the effects of those selfish passions which separated nations when they were yet barbarous. It required a high degree of cultivation to break down those barriers consecrated by their antiquity, and the accomplishment of this important change evinces the rate at which the present age is advancing.

A new era in the history of the world began when China was opened to European intercourse ; but many years must pass before European influence can penetrate that vast empire, and eradicate those illiberal prejudices by which it has so long been governed.

Two important triumphs yet remain to be achieved by the science and energy of man over physical difficulties, namely, the junction of the Pacific and Atlantic oceans at the Isthmus of Central America, and the union of the Red Sea with the Mediterranean at Suez : when these are accomplished, the expectation of Columbus will be realized—of a passage to the East Indies by the Atlantic ; then Alexandria, Venice, and Southern Europe will regain, at least in part, the mercantile position which they lost by the discovery of Vasco de Gama.

The advantages of colonization and commerce to the less civilized part of the world are incalculable, as well as to those at home, not only by furnishing an exchange for manufactures, important as it is, but by the immense accession of knowledge of the earth and its inhabitants that has been thus attained.



The history of former ages exhibits nothing to be compared with the mental activity of the present. Steam, which annihilates time and space, fills mankind with schemes for advantage or defence; but however mercenary the motives for enterprise may be, it is instrumental in bringing nations together, and uniting them in mutual bonds of friendship. The facility of communication is rapidly assimilating national character. Society in most of the capitals is formed on the same model; individuality is only met with in the provinces, and every well-educated person now speaks more than one of the modern languages.

At no period has science been so extensively and so successfully cultivated; the collective wisdom and experience of Europe and the United States of America is now brought to bear on subjects of the highest importance in annual scientific meetings, where the common pursuit of truth is as beneficial to the moral as to the intellectual character, and the noble objects of investigation are no longer confined to the philosophic few, but are becoming widely diffused among all ranks in civilized nations, and the most enlightened governments have given their support to measures that could not have been otherwise accomplished. Simultaneous observations are made in numerous places, in both hemispheres, on electricity, magnetism, on the tides and currents of the air and the ocean, and those mysterious vicissitudes of temperature and moisture which bless the labours of the husbandman one year and blight them in another.

The places of the *nebulæ* and fixed stars, and their motions, are known with unexampled precision, and the most refined analyses embrace the most varied objects. In the far heavens, from unaccountable disturbances in the motions of Uranus, an unknown and unseen body was declared to be revolving on the utmost verge of the solar system: it was found in the very spot pointed out by analysis; and on earth, though hundreds of miles apart, the invisible messenger, electricity, instantaneously conveys the thoughts of the invisible spirit of man to man—results of science sublimely transcendental.

The attempt would be vain to enumerate the improvements in machinery and mechanics; to follow the rapid course of discovery through the complicated mazes of magnetism and electricity, the action of the electric current on the polarized



sun-beam, one of the most beautiful of modern discoveries, leading to relations hitherto unsuspected between that power and the complex assemblage of visible and invisible influences in solar light, by one of which nature has recently been made to paint her own likeness. It is equally impossible to convey an idea of the rapid succession of the varied and curious results of chemistry, and its application to physiology and agriculture; moreover, distinguished works have lately been published at home and abroad on the science of mind, which has been so successfully cultivated in our own country. Geography has assumed a new character by that unwearied search for accurate knowledge and truth that marks the present age, and physical geography is altogether a modern science.

The spirit of nautical and geographical discovery, begun in the fifteenth century, by those illustrious navigators who had a new world to discover, is at this day as energetic as ever, though the results are necessarily less brilliant. Neither the long gloomy night of a polar winter nor the dangers of the ice and the storm deter our gallant seamen from seeking a better acquaintance with "this ball of earth," even under its most frowning aspect, and that for honour, which they are as eager to seek even in the cannon's mouth. Nor have other nations of Europe or America been without their share in these bold adventures. The scorching sun and deadly swamps of the tropics as little prevent the traveller from collecting the animals and plants of the present creation, or the geologist from investigating those of ages long gone by. Man daily vindicates his birth-right as lord of the creation, and compels every land and sea to contribute to his knowledge.

The most distinguished modern travellers, following the example of Baron Humboldt, the patriarch of physical geography, take a more extended view of the subject than the earth and its animal and vegetable inhabitants afford, and include in their researches the past and present condition of man, the origin, manners, and languages of existing nations, and the monuments of those that have been. Geography has had its dark ages, during which, the situation of many great cities, and spots of celebrity in history, sacred and profane, had been entirely lost sight of; which are now discovered



by the learning and assiduity of the modern traveller. Of this, Italy, Egypt, the Holy Land, Asia Minor, Arabia, and the basin of the Euphrates and Tigris, with the adjacent mountains of Persia, are remarkable instances, not to mention the vast region of the East. In many parts of the world the ruins of cities, of extraordinary magnitude and workmanship, show that there are wide regions of whose original inhabitants we know nothing. The Andes of Mexico and Peru have remains of civilized nations before the Incas; Mr. Stephens has found in the woods of Central America the ruins of great cities, adorned with sculpture and pictorial writings, which show that a race far advanced had once cultivated the soil where these entangled forests now grow. Picture-writings have been discovered by Mr. Schomburgk on rocks in Guiana, spread over an extent of 350,000 square miles, similar to those found in the United States and in Siberia. Magnificent buildings still exist, in good preservation, all over Eastern Asia, and many in a ruinous state belong to a period far beyond written record.

Ancient literature has furnished a subject of still more interesting research, which shows that the mind of man is essentially the same under very different circumstances; every nation far advanced in civilization has had its age of poetry, the drama, romance, and philosophy, each stamped with the character of the people and times, and still more with their religious belief. Our profound Oriental scholars have made known to Europeans the refined Sanscrit literature of Hindostan, its schools of philosophy and astronomy, its dramatic writings and poetry, which are original and beautiful.

The riches of Chinese literature and their valuable geography were introduced into Europe by the French Jesuits of the last century, and perfected by the French philosophers of the present; to that nation we also owe our knowledge of the letters and poetry of ancient Persia: and from the time that Dr. Young deciphered the inscriptions on the Rosetta Stone, Egyptian hieroglyphics and picture-writing have been studied by the learned, and we have reason to expect much new information from Professor Lipsius, of Berlin. The Germans indeed have left no subject of ancient literature unexplored, even to the language spoken at Babylon and Nineveh.



The press has overflowed with an unprecedented quantity of literature, some of standard merit, and much more that is ephemeral, suited to all ranks and on every subject ; and with the aim, in our own country at least, to improve the people and to advocate the cause of virtue. All this mental energy is but an effect of those laws which regulate human affairs, and include in their generality the various changes that tend to improve the condition of man.

The fine arts do not keep pace with science, though they have not been altogether left behind. Painting, like poetry, must come spontaneously, because a feeling for it depends upon innate sympathies in the human breast. Nothing external could affect us unless there were corresponding ideas within ; and poetically constituted minds of the highest organization are most deeply impressed with whatever is excellent. All are not gifted with a strong perception of the beautiful, just as some persons cannot see certain colours or hear certain sounds. Those elevated sentiments which constitute genius are given to few ; yet something akin, though inferior in degree, exists in most men. Consequently, though culture may not inspire genius, it cherishes and calls forth the natural perception of what is good and beautiful, and by that means improves the tone of the national mind, and forms a counterpoise to the all-absorbing useful and commercial.

Historical painting is successfully cultivated both in France and Germany. The Germans have modelled their school on the true style of the ancient masters. They have not, indeed, attained their richness of colouring, but many of their designs are poetry embodied ; and French artists, following in the same steps, have produced historical works of extraordinary merit. Pictures of the *genre* and scenes of domestic life have been painted with much expression and beauty by our own artists ; and British landscapes are not mere portraits of nature, but pictures of high poetical feeling ; and the perfection of their composition has been acknowledged all over Europe by the popularity of the engravings that illustrate many of our modern books. The encouragement given to this branch of art at home may be ascribed to the taste for a country life so general in England. Water-colour painting, which is entirely of British growth, has now become a



favourite style in every country, and is brought to the highest perfection in our own.

The Italians have had the merit of restoring sculpture to the pure style which it had lost; and that gifted people have produced some of the noblest specimens of modern art. The greatest genius of his time left the snows of the far North to spend his best days in Rome, the head-quarters of the art; and our own sculptors of the most eminent talents have established themselves in Rome, where they find a more congenial spirit than in their own country, where the compositions of Flaxman were not appreciated till they had become the admiration of Europe.

The opera, one of the most refined of theatrical amusements in every capital city in Europe, shows the power and excellence of Italian melody, which has been transmitted from age to age by a continued succession of great composers. German music, partaking of the learned character of the nation, is rich in original harmony, which requires a cultivated taste to understand and appreciate.

Italy is the only country that has had two poetical eras of the highest order; and great as the Latin period was, that of Dante was more original and sublime. The Germans, so eminent in every branch of literature, have been also great as poets: the power of Göthe's genius will render his poems as permanent as the language. France is, as it long has been, the abode of the Comic Muse; and although that nation can claim great poets of a more serious cast, yet the language and the habits of the people are more suited to the gay than the grave style. Though the British may have been inferior to other nations in some of the fine arts, yet poetry, immeasurably the greatest and most noble, redeems, and more than redeems us. The nation that has the poetry of Chaucer, Spenser, Shakspeare, and Milton, with all the brilliant train down nearly to the present time, must ever hold a distinguished place even as an imaginative people. Shakspeare alone would stamp a language with immortality. The British novels stand high among works of imagination: they have generally had the merit of advancing the cause of morality. Had the French novelists attended more to this, their knowledge of the human heart and the brilliancy of their composition would have been more appreciated.



Poetry of the highest stamp has fled before the utilitarian spirit of the age, yet there is as much talent in the world, and imagination too, at the present time, as ever there was at any period, though directed to different objects; but what is of more importance, there is a constant increase of liberal sentiment and disinterested benevolence. Three of the most beneficial systems of modern times are due to the benevolence of English ladies,—the improvement of prison discipline, savings-banks, and banks for lending small sums to the poor. The success of all has exceeded every expectation at home, and these admirable institutions are now adopted abroad. The importance of popular and agricultural education is becoming an object of attention to the more enlightened governments; and one of the greatest improvements in education is that teachers are now fitted for their duties by being taught the art of teaching. The gentleness with which instruction is conveyed no longer blights the joyous days of youth, but, on the contrary, encourages self-education, which is the most efficient.

The system of infant schools, established in many parts of Europe and throughout the United States of North America, is rapidly improving the moral condition of the people. The instruction given in them is suited to the station of the scholars, and the moral lessons taught are often reflected back on the uneducated parents by their children. Moreover, the personal intercourse with the higher orders, and the kindness which the children receive from them, strengthens the bond of reciprocal good feeling. Since the abolition of the feudal system, the separation between the higher and lower classes of society has been increasing; but the generous exertions of individuals, whose only object is to do good, is now beginning to correct a tendency that, unchecked, might have led to the worst consequences to all ranks.

The voluntary sacrifices that have lately been made to relieve the necessities of a famishing nation show the humane disposition of the age. But it is not one particular and extraordinary case, however admirable, that marks the general progress—it is not in the earthquake or the storm, but in the still small voice of consolation heard in the cabin of the wretched, that is the prominent feature of the charities of the present time, when the benevolent of all ranks seek for



distress in the abode of poverty and vice, to aid and to reform. No language can do justice to the merit of those who devote themselves to the reformation of those children who have hitherto wandered neglected in the streets of great cities, in the unpromising task in which they have laboured with patience, undismayed by difficulties that might have discouraged the most determined; but they have succeeded. The language of kindness and sympathy, never before heard by these children of crime and wretchedness, is saving multitudes from perdition. But it would require a volume to enumerate the exertions that are making for the accommodation, health, and improvement of the people, and the devotion of high and low to the introduction of new establishments and the amelioration of the old. Noble and liberal sentiments mark the proceedings of public assemblies, whether in the cause of nations or of individuals; and the severity of our penal laws is mitigated by a milder system. Happily this liberal and benevolent spirit is not confined to Britain; it is universal in the states of the American Union; it is spreading widely through the more civilized countries of Europe. A noble instance that has lately surprised all Europe shows how rapidly the wise measures of a truly great and good sovereign are raising a fine people to that place among the nations which they had lost. No retrograde movement can now take place in civilization; the diffusion of Christian virtues and of knowledge insures the progressive advancement of man in those high moral and intellectual qualities that constitute his true dignity. But much yet remains to be done at home, especially in religious instruction and the prevention of crime; and abroad millions of our fellow-creatures in both hemispheres are still in the lowest grade of barbarism. Ages and ages must pass away before they can be civilized; but if there be any analogy between the period of man's duration on earth and that of the frailest plant or shell-fish of the geological periods, he must still be in his infancy; and let those who doubt of his indefinite improvement compare the state of Europe in the middle ages, or only fifty years ago, with what it is at present. Some, who seemed to have lived before their time, were then prosecuted and punished for opinions which are now sanctioned by the legislature and acknowledged by all.



'The moral disposition of the age appears in the refinement of conversation. Selfishness and evil passions may possibly ever be found in the human breast ; but the progress of the race will consist in the increasing power of public opinion, the collective voice of mankind, regulated by the Christian principles of morality and justice. The individuality of man modifies his opinions and belief ; it is a part of that variety which is a universal law of nature ; so that there will probably always be difference of views as to religious doctrine, which, however, will become more spiritual and freer from the taint of human infirmity ; but the power of the Christian religion will appear in purer conduct, and in the more general practice of mutual forbearance, charity, and love.

THE END.

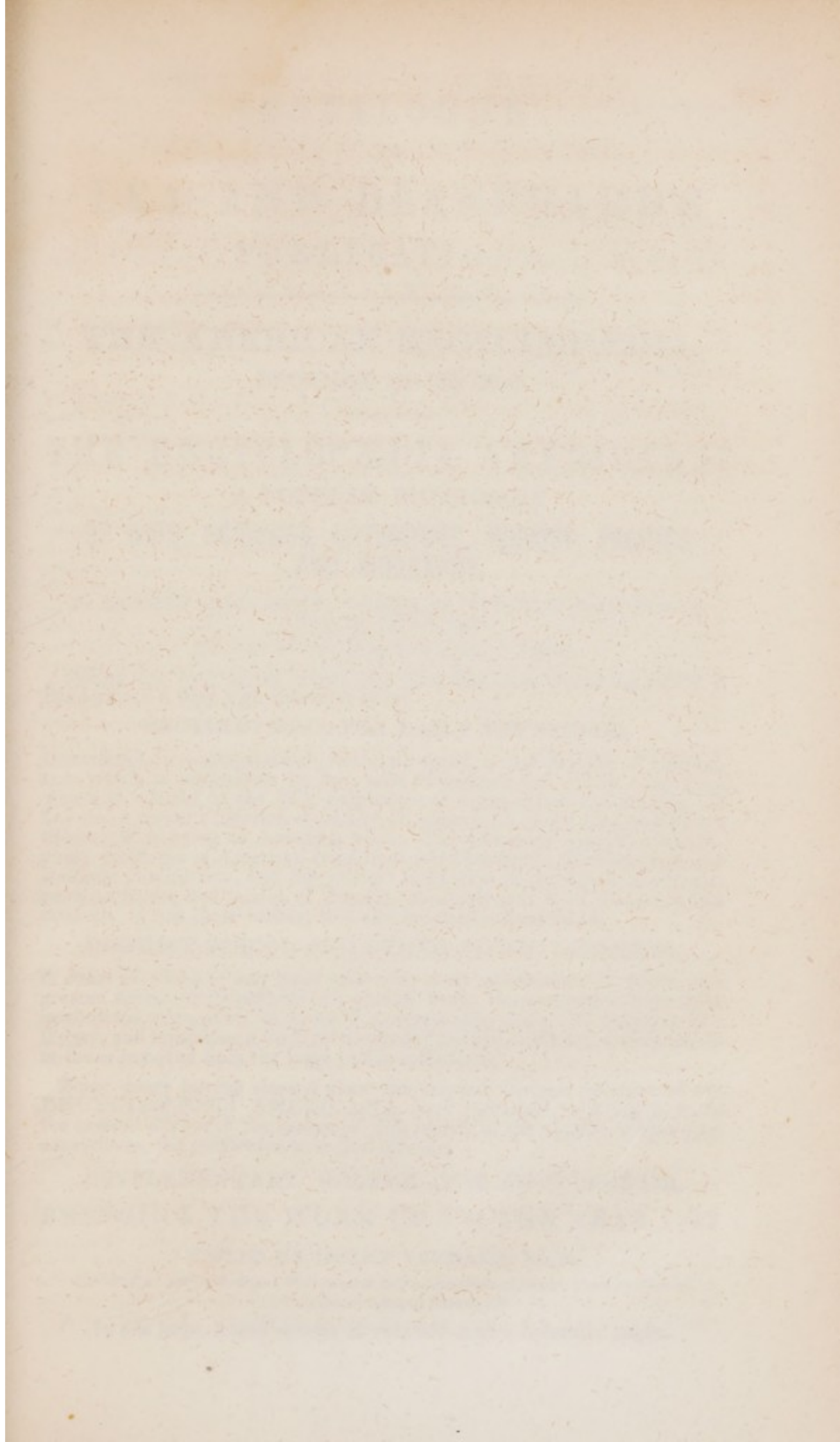


The moral disposition of the age appears in the reluctance of conversion. Selfishness and evil passions may possibly ever be banished from the human breast; but the progress of the race will consist in the increasing power of public opinion, the collective voice of mankind, regulated by the Christian principles of morality and justice. The individuality of man, whether his opinions and beliefs be a part of that variety which is a universal law of nature; so that there will probably always be difference of views as to religious doctrine, which, however, will become more spiritual and free from the taint of human infirmity; and the power of the Christian religion will appear in purer conduct, and in the more general practice of mutual forbearance, equity, and love.

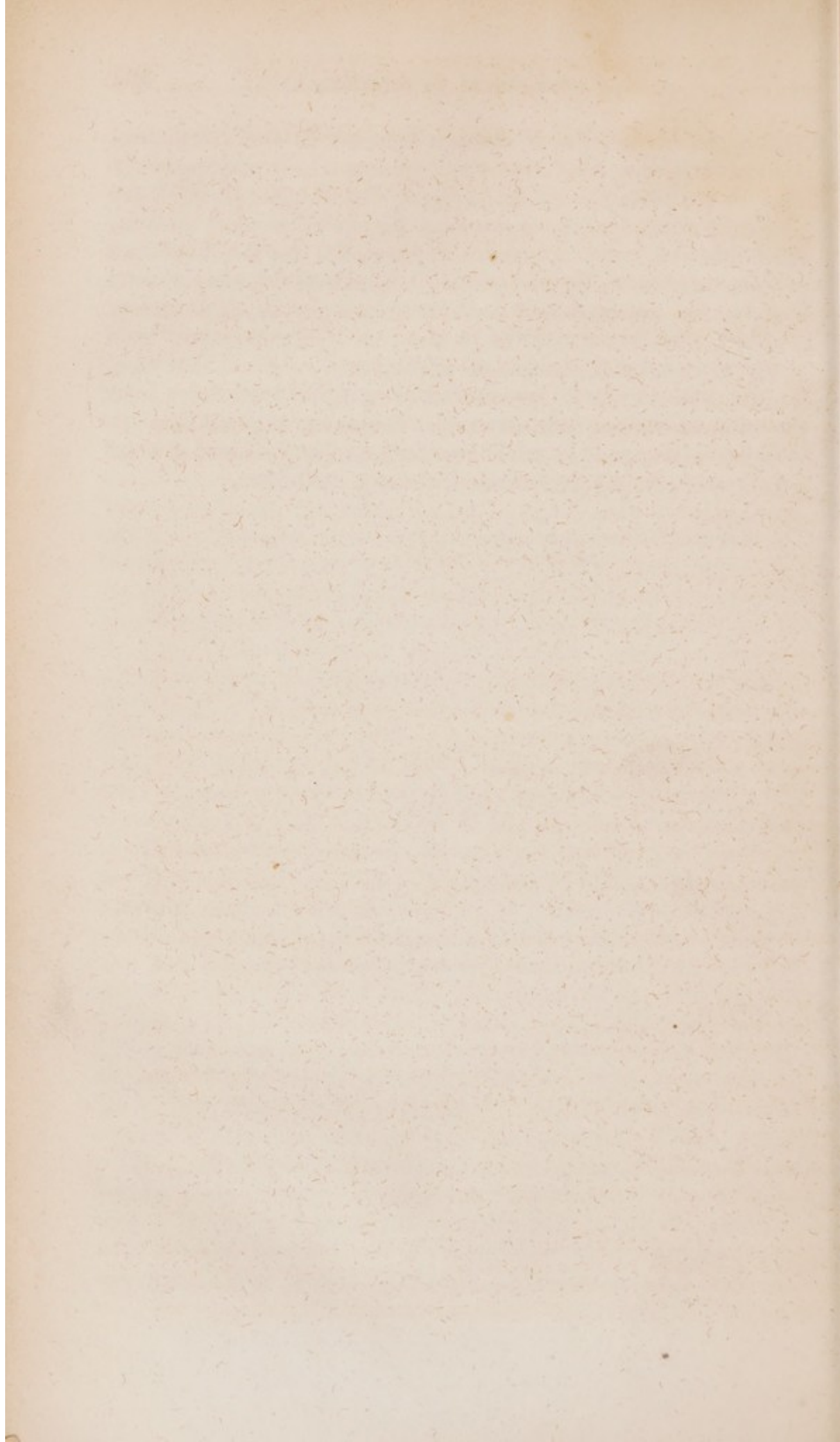
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
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