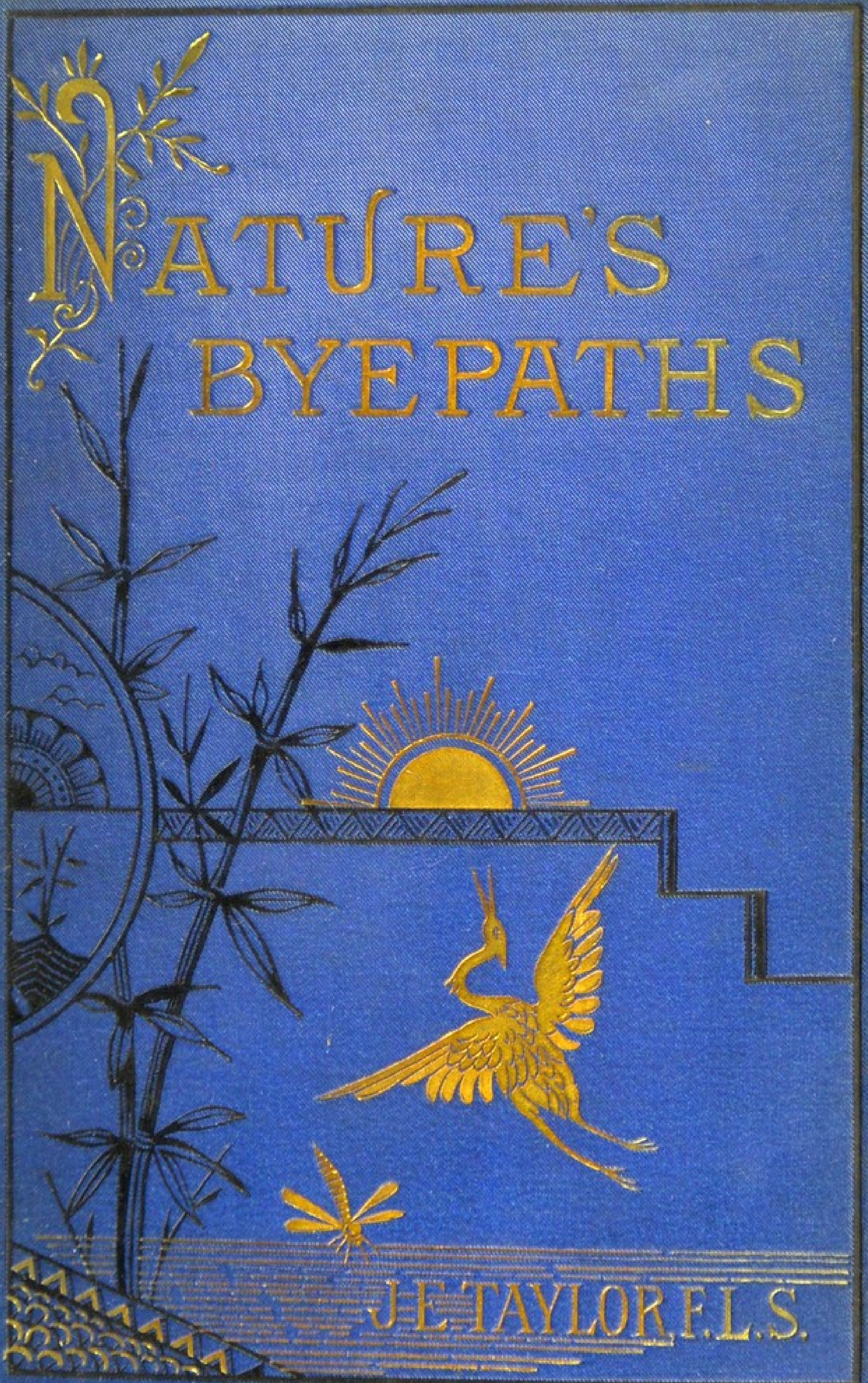
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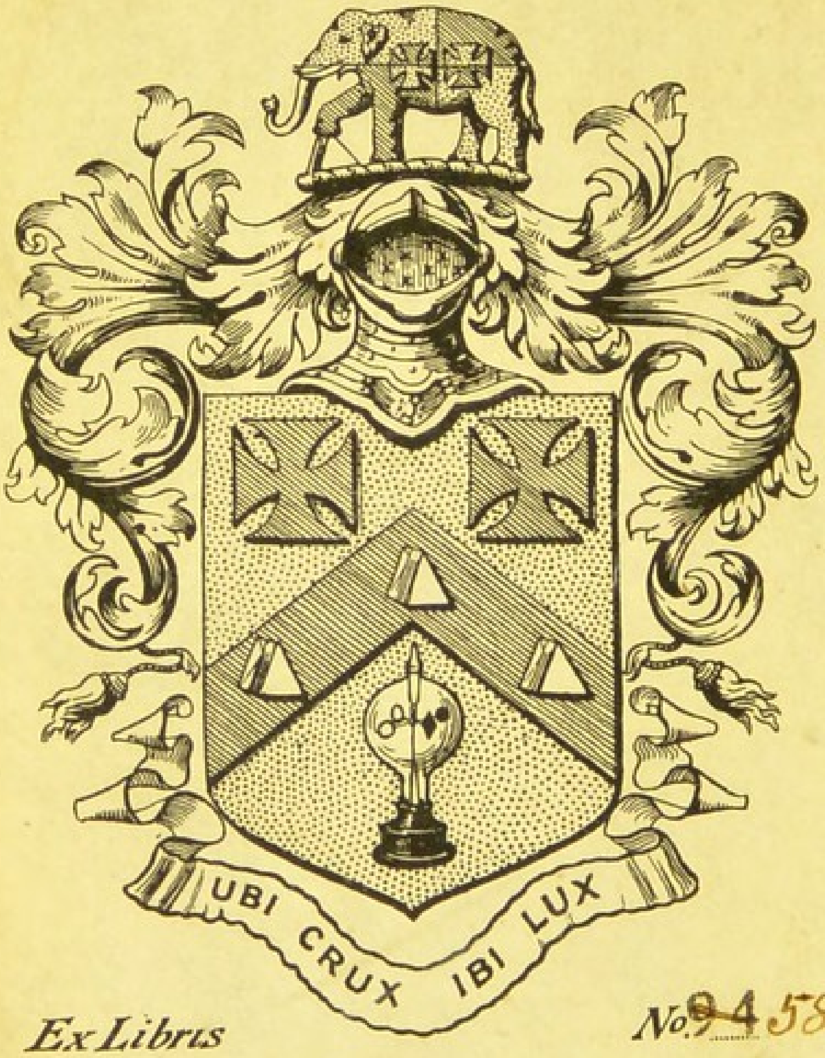
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NATURE'S BYEPATHS

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A SERIES OF RECREATIVE PAPERS

IN

NATURAL HISTORY

BY

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NATURE'S BYEPATHS.

CHAPTER I.

SUBTERRANEAN MOUNTAINS.

POSSIBLY no social crises have been without national importance. The general series of strikes for higher wages, and the reckless manner with which the coal-miners refused to work except their arbitrary demands were complied with, coupled with the high price to which coals have risen in the market, have set men a-thinking about the possibility of adding to the coal supply. The geology of Great Britain is pretty well known, and everywhere mining engineers and landed proprietors have been asking whether the existing coal-fields may not be profitably worked under strata of a later age ; and whether, here and there, a continuation of the area of certain coal-fields may not be discovered so as to make coal-mining profitable in new localities. Among other places, Norfolk has been suggested, and even our most eminent geologists—those who know most about such matters, as Messrs. Prestwich and Godwin-Austen — listen favourably to the suggestion. The Directors of the Great Eastern Railway are alive to the theoretical advantages, and some time ago invited eminent geologists to confer with them as to the desirability of some time commencing experimental borings somewhere in Norfolk or Suffolk. In West Lancashire, Leicestershire, and near Lincoln, it has been mooted to start similar experimental borings, so that in a short time we may hope to be in possession of some valuable national information on this most important question. Sussex has been distinguished by the Sub-Wealden enterprise, and the odds are, we shall have one commenced in the Eastern Counties ere long.

Let us briefly endeavour to give the reasons for the welcome conjecture that in Norfolk or Suffolk we may have available coal measures lying at no great depth under us. The localities mentioned in the "shires" all lie more or less in the great area which has generally been regarded as coal-producing, and therefore it does not seem such a matter for surprise that the margins of the already-worked coal-fields should be extended on every side. What is far more surprising and unexpected is that far away to the south-east and east of England it should be deemed possible that the coal strata lie beneath those of the chalk!

It cannot be denied that the subject is one of considerable difficulty to people who don't pretend to know anything about geology. But that science is now exercising such an important influence upon modern thought that it can no longer be withheld from a liberal education. To fully understand everything about how the coal strata lie in the crust of the earth, we are required to be acquainted with the succession and distribution of rock-masses; and also with the physical geography of the ancient seas along whose bottoms these rocks were originally formed, as well as with the disturbances which have taken place since then. But even with all these scientific difficulties bristling round the subject, and rendering it anything but readable to such as have never attempted anything more than novels, we do not think it impossible to bring it before the attention of a non-scientific public so that the latter will care to read about it, if only for the sake of its probably influential value. Among the many wonders which geology has placed before the public, none is more striking than the immense periods of time during which our earth has been in existence. Accumulations of ancient vegetation have been covered up with other deposits, and quietly stored away as coal. Creation after creation of animals and plants has passed away, and their remains packed up in the rocks of the earth's crust. The dry land of every geological epoch has been mapped with mountain-chains, plains, lakes, and rivers, just as the surface of the earth is now. For ages these various mountains were exposed to similar atmospherical wear and tear, the materials thus stripped off being carried away by rivers, etc., to the sea, to form deposits of a later date. There is no reason to suppose that this wear and tear was much more rapid than we see it going on around us, but it extended over such a long period of time that sedimentary rocks were formed, even before man's appearance on the earth, that had reached a total thickness of over 19 miles! Volcanic outbursts and upheavals compensated for this wear and tear, and thus the relative conditions of land and water were always maintained, although their areas changed with the different epochs.

It will be seen that the physical geography of any of the *past* geological periods cannot be guessed at merely from the present surface arrangement—that is to say, the mountains and plains, the seas and rivers, which distinguish our globe now, bear little or no reference to those of former periods. Let us suppose that the entire area of Great Britain was slowly sinking (as we know the northern parts of Europe to be at the present time), and that this sinking were to be continued say for millions of years! What would be the result? That as the land sank the sea would gain, first on the lowest parts, would extend farther and farther, until when the depression had reached its climax the highest hills would be covered. The marine muds and sands would first be strewn over the plains, and the formations would gradually increase in thickness, until eventually they would bury and cover up the very mountain peaks! If Snowdon or Ben Nevis or such a range of hills as the Pennine Chain were to be thus gradually entombed beneath a layer of rock to the depth of a thousand feet by such a great mud-sheet, then a huge plain would be the effect of the last great geological operation, and when this was uplifted from the sea-bottom, where it was formed, and inhabited by man, few people would dream of the mountain-chains that were buried beneath it. We are here only boldly sketching what the geologist can prove has repeatedly taken place. But suppose that the ancient rocks of such a buried Snowdon or Pennine Chain were coal strata. Then it would be evident, if we wanted to find coal beneath the newly-formed plain, that our plan would be to hit upon the place where these mountains are only a thousand feet below. For if we went farther away we should come over where the *original* plains lay below, at a depth of thousands of feet more, so that even if they were formed of coal rocks the great depth would utterly preclude coal-mining. It may seem strange to apply this supposition, but it can be *proved* that such a chain of buried mountains does extend beneath the eastern and south-eastern counties of England. This ancient ridge appears to slope off gradually north and south, so that, farther away from a given point, strata overlying it grow thicker. Of the rocks comprising this buried mountain-chain, those containing coal form only a part. We know, further, that these ancient mountains must have long been exposed to meteorological wear and tear, so that thick strata have been denuded and stripped off.

Let us briefly sketch the brilliant generalisation—it can be called by no other name—which led to the belief that a ridge of ancient rocks thus stretched across the eastern and south-eastern counties long before any *facts* concerning it were known. More than twenty years ago Mr. Godwin-Austen read a paper before the Geological Society of London on the subject, and as he stands in the first rank of those geologists who have studied the physical geography of the ancient seas, and, therefore, of the distribution of their sedimentary deposits or *rocks*, his views were listened to with the respect they deserved. In that paper Mr. Austen showed that the coal-fields of Bristol and South Wales, on the west, and of Northern France, in the east, were merely "outcrops" (or places where the coal strata came to the surface), of one continued area. Both these widely separated coal-fields have the same "strike" or *run* of their rocks. It is evident, therefore, that the Somersetshire range of hills, and that of the Ardennes, in Belgium, are continuations; and the deduction is that this continuity is *only broken as far as surface appearance is concerned,* and that, beneath subsequently formed strata which have covered these hills up in the manner we have asked our readers to suppose it is still maintained. In fact, a great depression has bellied down an extensive part of this ancient ridge, and it is in the hollow that the later rocks rest.

A few years after Mr. Godwin-Austen's theory was put forth it obtained verification in a remarkable manner. A deep well had to be bored in Kentish Town, in London, over where, if the theory were true, the ancient ridge lay below. The borers passed through the Tertiary strata, as well as through the various subdivisions of the chalk, and then, at a depth of about 1300 feet, they came upon some queer-looking primary or ancient rocks. In fact, they had hit upon a part of the mountain-chain buried below! No fossils were obtained, and this was an unfortunate circumstance, as geologists are as well able to tell the age and position of a rock by its fossils, as a gardener is to tell a tree by its fruit. But, as far as appearance and mineralogical structure went, the best authorities were of the belief that the ancient rocks thus reached belonged to the geological formation known as the Devonian. Now, this formation lies *below* the true coal-bearing rocks, so that in this particular spot the latter had either been stripped off or had never been deposited there. The former idea is believed to be the correct one. Professor Prestwich had been of the same opinion as Mr. Austen respecting the extent of the ancient and buried-up ridge, and both these gentlemen gave their full reasons for holding it before the Royal Coal Commission, where our readers who are curious may find their complete evidence printed in 1871.

Not long after the boring at Kentish Town had taken place, the Harwich Corporation commenced their waterworks, and several wells were bored to furnish the necessary water supply. The deepest went to 1070 feet, and here, at a depth of nearly 200 feet *less* than in London, the old ridge was again reached. This time, however, the Carboniferous or "coal-bearing" rocks *were* touched, and fossils obtained which are peculiar to that formation, so that the age and relative position of the ridge were at once known. But the part of the coal rocks thus reached was the *lowest*—that immediately resting on the sloping Devonian rocks, which we have seen underlie the metropolis. The part of the coal formation where the coal seams occur is the upper, consequently, if the latter rocks incline on the Harwich beds as those do on the metropolitan, we should have to go a little farther *north* to find them, and this would bring us to the borders of Norfolk and Suffolk.

To prove that the ancient coal vegetation extended over the Norfolk and Suffolk area, we have only to notice the fact that coal is worked much farther to the south, near Calais, in France, where it is profitably wrought at a depth of 1500 feet. There the true coal-bearing rocks lie just underneath the chalk, the secondary strata being absent as they are under Harwich and London. The great axis of rocks, chiefly Silurian, Devonian, and Carboniferous, which constitute the Ardennes chain, in Belgium, dips westwards under the chalk of Northern France, and has been traced underground nearly as far as Calais. Nearer Boulogne these rocks are close to the surface, and they crop up in the Boulonnais from beneath the chalk. There can be no doubt that the ancient mountain-chain of which the Mendips still stand above at the western end, and the Ardennes at the eastern, like all mountain-chains, did not run in a straight direction, but was a curving line. Hence there is a difficulty to know how the line runs beneath us. Only repeated experiments can give us the necessary information, and a rich nation like England ought to conduct some borings in the interest of coming generations. Another thing which has to be considered in enquiring whether coal actually lies under the Eastern Counties is, whether the original rocks in which the coal-seams are imbedded have been denuded away before the later formed rocks were deposited. There is reason for supposing they have in some places, but not in all. Supposing the old ridge to extend at an available depth, and seeing the probability of the upper coal measures succeeding the lower as the latter must succeed the Devonian, then, at no great distance north of Harwich, they will most probably be met with. For many technical reasons Hunstanton has been suggested as a likely place for a trial boring—chiefly because the *lowest* part of the secondary rocks crop up there, and Professor Hull has shown that these thin out so rapidly to the south that the Oolite and New Red Sandstone formations are not likely to occur beneath London. Subsequent deep borings in and near the metropolis have proved the sagacity of Professor Hull's hypothesis. From the pebbles enclosed in the strata about Hunstanton, geologists know that when they were deposited some part of the ancient ridge of rocks stood above water, for the latter were actually broken up, and these fragments have entered into the composition of those now occupying the surface. The composition of the Lower Greensand in Cambridgeshire, Bedfordshire, Buckinghamshire, and elsewhere, shows, by its large angular grains of quartzite, that this deposit must have been formed in shoal water; and the abundant pebbles of old rocks, grains of quartzite, and even of *coal*, plainly indicate the neighbourhood of land composed of Palæozoic rocks. The number of Oolitic and other extraneous fossils, mixed up in the Cambridgeshire and Bedfordshire Greensand beds, with the fossils belonging to that formation, also indicates that the older secondary formation must have been very much denuded and otherwise broken up (as well as the Primary rocks), or we should not have such a strange medley of organic remains as we find in the Greensand phosphatic nodules.

On the other hand, it would appear certain that *south* of the ridge of underground mountains, the Oolitic and associated rocks are actually thicker than elsewhere in England. This was proved by the famous Sub-Wealden boring—an enterprise which was at once a glory and a disgrace to the British nation. It was a splendid scientific experiment to originate and carry on; it is a deeply lamented fact that in a wealthy country like England it had to come to an end just when every additional foot sunk deeper in the boring was getting of greater importance.

Whilst the boring was still in progress we had the opportunity of visiting the locality in Sussex where the "Sub-Wealden Exploration," as it was called, was made. St. Leonards was reached by rail, and we proceeded thence, by way of the famous town of Battle, to Netherfield. For miles after leaving Hastings, the road runs over hill and dale in nearly a straight line, thus indicating its possible Roman origin. The Norman invaders must have proceeded by this very road. Reaching Battle, we noticed how the physical character of the scenery suddenly changes close to the town, and we are told that this is due to an enormous "fault" or dislocation of the solid rocks beneath, which has brought up the lower beds to the surface. It is certain that this has operated upon English history, for it was chiefly by taking advantage of the position thus brought about that the Conqueror defeated the Saxons under Harold, and established a Norman dynasty in England. As we passed along these straight roads, with their high hedge-banks, we could not but think of that important event which occurred hereabouts eight centuries ago, and wonder what the England of the nineteenth century would have been, had the Norman invasion never taken place! The many bright flowers of an English summer were competing for the mastery of the luxuriant hedge-banks. Gnarled old oaks, chiefly dwarfed by the sea-breezes, lined the road-side, and occupied the same places they possibly held when the Norman troops marched past. But our eyes caught glimpses of a period infinitely older than that of the Normans, for the flag-stones which pave the sides of the road are each distinctly impressed with ripple-marks! They come from the formation known as the "Hastings Sands," one of the upper beds of the great Wealden deposit which underlies the whole of this part of Sussex. The Wealden was a secondary formation elaborated at the mouth of an enormous river as a delta, where the materials brought down accumulated until they reached a thickness of two thousand feet. Since then, these sedimentary beds have been converted into rock, but, as in the case of these ripple-marked sandstone flags, they still retain many traces of the physical and vital conditions that were in force at that distant epoch. In these deposits you obtain the remains of the great fossil reptiles, *Iguanodon, Megalosaurus*, etc., huge monsters thirty feet or more in length. We get fossil relics of palm-trees and tree-ferns which then clothed the dry land, and, as we approached Netherfield, we came to lime-stone beds composed entirely of the remains of fresh-water shells. A wonderful country is this, and one cannot wonder it should be so fertile, seeing that its subsoils are the remains of an old river delta, just as the fertile land of Egypt owes its riches to a similar physical cause.

We passed through the quiet old town of Battle, which seems as if the onward tide of progress had left it high and dry. From Battle we passed Norman-hurst, and other villages whose termination of *hurst* shows that they were founded in an ancient forest. The scenery is most magnificent. The country is one grand undulating, forest-clad area, and as such has very little altered its character since the days of the Saxons. Indeed, one cannot doubt that the sur-prised and affrighted remnants of Harold's army must have sought shelter amid these very coverts from the dreaded pursuit of their Norman foes! In our rapidly changed country, it is quite refreshing to come across spots so rich in incident, and so thoroughly unchanged since those incidents took place. At length we came to a denser part of the wood, away from the main road, and found our way down a tolerably steep declivity, covered with brushwood and loose fragments of limestone. The brook, which is still cutting its way through these beds, may be heard and seen below ; and there we get a good section of the beds, and as many of such fossil freshwater shells as we like, for these limestone layers are literally composed of nothing else. Just before we reached the stream, a little wooden shanty and the three wooden legs of a crane met our eyes. A portable engine was puffing out balls of steam and smoke, and the otherwise unbroken silence of this old English forest scene was disturbed. It would not have been difficult for us to imagine we were in Australia, and that this was some exploring party in search of gold. Here, however, was being carried on an underground exploration, suggested by the profoundest scientific sagacity, to which the keen attention of every geologist in Great Britain was directed.

We all know the result of this boring before it was stopped for want of funds. The upper Oolitic beds were found to be of extraordinary thickness, and practically all the money raised for carrying on the exploration was spent in boring through this one formation. But even the unsuccessful result of the Sub-Wealden Exploration has not been without its scientific value in tracking out the strike of the subterranean mountain-chain. We now know that the experiment was carried on *too far to the south* of London. And this conclusion is strengthened by more recent discoveries, the result of several deep-well borings in and near the Metropolis which, had they been known at an earlier period, would probably have had the effect of commencing the experiment elsewhere than in Sussex, and very probably in the north of Essex or the south of Suffolk.

Let us glance briefly at the nature of these metropolitan well-borings. We have already seen the effect which the deep borings at Kentish Town and Harwich had upon the idea that a ridge of Palæozoic rocks extended beneath the south-eastern counties. The well—and other borings at Burford (in Oxfordshire), Ware in Hertfordshire, Turnford, and at Meux's Brewery in Tottenham Court Road, London, have furnished the most complete confirmatory evidence of the trend of the subterranean mountain-range, and have also furnished us with specimens of its rocks and their fossils. At Burford, coal was actually reached beneath the overlapping of Oolitic rocks, and the nature of the fossil plants, etc., indicates that this is an underground extension of the Bristol and Forest of Dean coal-field. Burford is thirty-five miles *east* of either, and thus we have actually proved the Somersetshire coal-field to be running in an easterly direction, whilst similar borings beneath the secondary rocks of Northern France have proved that the Ardennes coal strata extend underground as far as Calais. The trial-boring for these buried-up strata will have to be made, in the future, somewhere along the line connecting Burford with Calais, which line will be more or less mapped out for speculative geologists by the recent well-borings in and about London.

Between Ware and Burford is a distance of about eighty miles. It would be a most valuable experiment to institute a trial-boring somewhere between these two points. The depth to which the shaft was sunk at Ware before the buried-up Palæozoic rocks were reached was only eight hundred feet. Here the Upper Silurian strata were struck, and the boring tool brought up cores which showed the very angle at which the rocks were dipping, although, owing to the tool having to be turned round, it was not possible to tell the *direction* of the dip. Mr. Etheridge, of the Geological Survey, has published a list of thirty-three species of well-known Silurian fossils which were imbedded in the cores. At Turnford, at the depth of nine hundred and eighty feet, Devonian rocks were reached. At Loughton, palæozoic strata were struck at one thousand and ninety-two feet from the surface; and at Meux's deep well-boring, at a depth of eleven hundred and forty-eight feet, Devonian rocks were also reached, in which certain characteristic Devonian fossils were imbedded; whilst the mineralogical character of the strata is said to be wonderfully similar to the Devonian rocks of the Ardennes, and of other places in Northern France. The Lower Greensand was found to be resting on the Devonian rocks at Meux's, but so altered from its general character as to indicate it was here a shore deposit, formed on and around the ancient Palæozoic chain of hills. Here is evidence, therefore, of the last disappearance beneath the sea of what may have been for ages a range of Silurian and Devonian and even Carboniferous rocks, continuing as an elevated track from North Wales and the Mendip Hills right away into Germany.

Notice has already been made of the striking resemblances, in many physical characters, between the Somersetshire coal-field in the west, and the French and Belgian coal-fields in the east. The Carboniferous strata occur in small basins, owing to the rocks having been squeezed and folded. In France the strata are so much folded that in places the formations have been reversed; and recently, in the full belief that the foldings had thus flexed the rocks until they had been locally reversed, borings were carried on in the Boulonnais district through the Devonian and Carboniferous limestone rock, and the coal strata were found beneath! All along the trend of the subterranean range of hills there can be no doubt the strata are highly inclined and considerably folded, so that the coal-fields must lie in comparatively small basins.

We have said enough, however, to show how modern science seizes isolated and seemingly disconnected facts, and, by properly connecting them, arrives at the most nationally important generalisations. Should the reasoning hold good, and the experiments we have mentioned, past and future, end in the discovery of new coal-fields, we shall have another illustration of the genuine seership of science.

CHAPTER II.

OVER AN OLD-LAND SURFACE.

IT was recently our good fortune to explore and personally examine one of the most interesting old-land surfaces in Europe.

In the south-easterly parts of France the geological formation termed the Oolite extends over an enormous area. Large rivers, such as the Lot, Aveyron, and Garonne, have excavated wide valleys out of the rolling and uneven tableland of Oolitic limestone. Nowhere in sunny France is more beautiful scenery to be found than in the bosoms of these valleys. Life flows along in a quiet, unbroken fashion. The land of the vales is wonderfully rich, for the inundations of the rivers cover the cultivated areas from time to time with newly fertilising soils.

Maize, tobacco, lucerne, and rye carpet the low-lying lands with sheets of splendid greenery. The slopes of the somewhat precipitous hills are clad with little vineyards, or packed with forests of young trees intended ultimately to serve for fuel in the absence of coal. No railways have as yet invaded this pleasant region, and the aspect of things has not much changed during the last two hundred years. There are no large landed proprietors, and no capital therefore has to be expended in the newest scientific agricultural improvements. Ploughing is still performed with a rude wooden implement drawn by a couple of oxen or cows. The whole country is mapped out into neat little enclosures. Every peasant is a landowner, and has a "stocking" in which his hard-earned savings are stored away. The people labour from early morn to dewy eve, for each is working for himself.

A new industry has recently arisen in this part of France. A few years ago a retired army surgeon, who had picked up a smattering of geology, found some queer-looking stones lying on the surface of the rubbly ground in the department of the Aveyron. He was curious enough to have them analysed, when they were discovered to be phosphate of lime, now called "phosphorite." Few minerals have been more largely sought after than this since Liebig suggested the application of mineral manures to soils, and when the phosphate of lime deposits in the south of France were heard of in England, companies and private firms commenced exploring them. Plots of land belonging to peasant proprietors were purchased, or the phosphates known to underlie them were worked by paying a royalty of so much per ton.

These phosphate deposits have brought to light the remains not only of an old-land surface but of the animals which swarmed over it during the period known as the later Eocene or the early Miocene. The places where the phosphate mines are most extensively worked are Montauban, Caylux, St. Antonin, Quercy, and Bach. All these are upon the wide-stretching plateau of Oolitic limestone. The phosphate occurs, as a rule, only on the highest ground, or on the summits of the rounded hills. There it partly fills up old caverns or gullies which were once ravines or gorges. During the process of extraction these ancient modifications of the surface are in a great measure restored to their original conditions—the caverns are once more hollow and empty, and the gorges are opened out just as they naturally existed during the early Miocene period. All around the summits of the hills the limestone must have been sorely weathered and denuded since that distant epoch, so that these caverns and gorges are only the relics of a dry land surface which was once as chequered with them as is now the mountain limestone of Yorkshire and Lancashire with "swallow-holes" and caves, and that of Derbyshire with such gorges as "Cave Dale" and the "Winnats." If we could restore all the carbonate of lime which the rivers have carried away to unknown seas in the interim, it would go far towards levelling up the valleys and hollows to the height of the hill-tops. There are no traces of "drift" deposits hereabouts, and therefore we have every reason to suppose the country was dry land at the time when Great Britain was wrapped in a vast Greenland-like ice-sheet.

In these ancient French gorges are a few traces of another formation which overlay the limestone in places, but has since been removed by denuding agencies. Some of the larger of them are filled up with a kind of coarse, well-bedded sandstone, resembling many of those formed during the middle Tertiary epoch. Evidently this once extended over part of the country, but the wear and tear of atmospherical action has removed it elsewhere, having planed down the rocks of the neighbourhood and left nothing of the sandstone formation but what was preserved in these sheltered positions. The sides of these ancient gorges and caverns are covered with layers of stalagmite, which has evidently oozed out of the limestone rocks, just as we may see it now in the well-known and much visited caves of Matlock and the Peak district. It is caused by water in which lime is dissolved finding its way out of the rock along the walls of caves, etc. Part of the water is absorbed by the air, and thus the lime which it previously contained is precipitated as a fine film. In time it upholsters the rugged rock surface like petrified drapery. In most caves and fissures the stalagmite thus formed is carbonate of lime, but in these particular French caves and gorges it is phosphate of lime. You may see it covering the sides, bottoms, and surfaces, everywhere, in many places for several feet in thickness. This is what the miners term "best quality," as it contains from seventy to eighty per cent of phosphate, the rest being chiefly a carbonate of lime, or ordinary stalagmite. The mineral has all the appearance of a banded agate, owing to the slow stages of deposition being represented by so many layers. Numbers of the smaller hollows and fissures are filled up almost entirely with the phosphate, and then it has all the appearance of what the miners would call "pockets."

The phosphate of lime may owe some of its origin to the soft bodies of the animals whose solid remains are still preserved in many parts of the limestone as fossils, but few geologists can doubt that it really represents the dissolved bones of the Mid-Tertiary mammals, which anciently roamed over this old-land surface, and left their skeletons to be atmospherically decomposed. Anyhow, it is of animal origin, collected by percolating water from the rock, and deposited in hollow gorges, fissures, or caverns. As a rule caves are only found in limestone rocks where they have been formed by underground streams. Fissures, also, as well as gorges, are often the result of weather and water acting along the surfaces of natural joints until they have separated them some distance asunder. In our limestone districts this process is still going on, and is visible in every stage. Clearly neither "pockets" nor "veins" of any mineral could be formed unless the hollows or fissures had been previously excavated. Then it becomes the work of the oozing water to throw down any mineral it may hold in solution. In this manner a good many well-known mineral deposits have originated. The extensive mines of hæmatite in the neighbourhood of Whitehaven are only stalagmites of iron ore, formed layer upon layer like the coats of an onion, in ancient caves of the Carboniferous limestone. The iron ore in the Whitehaven caves may have had its origin in the Triassic or Oolitic epoch, when the limestone was covered with Carboniferous sandstone containing nodules of impure iron, which was partially decomposed and carried down by the percolating water to be deposited in the subterranean caverns beneath until they were partly or entirely filled up. Eventually this overlying series of rocky strata was stripped off and the limestone was laid bare, with its iron ores in many instances cropping out to the daylight. The malachite deposits in the Ural Mountains and Australia are in like manner stalagmitic formations of carbonate of copper, filling up ancient hollows with their peculiar banded layers. The surfaces of all the mineral accumulations which have originated in this peculiar way are covered with smooth knobs,—

"mammillated" is the term employed to describe them by geologists.

In the phosphate beds of the South of France, by the gradual formation of thin layers of fresh phosphorite, the fissures have been solidly filled up, so that the mineral has the appearance of veins. In the case of widely separated cavities or gorges in the limestone the phosphorite does not fill up the whole. It generally lines the walls for a foot or two on each side, the middle being occupied by other deposits, in which, however, a good deal of impure phosphatic matter is distributed.

To the geologist the caverns which have been opened out in excavating for phosphate of lime are by far the most interesting. In some instances they are of great extent. We explored one which was some hundreds of yards in length, and had a roof fifty feet high. Another could not have had a less height of roof than seventy or eighty feet. These extensive caverns, with the exception of the stalagmitic layers of phosphorite on the walls, are often filled with a kind of reddish clayey rubble, containing an abundance of bones, skulls, and teeth of extinct animals. The preservation of these specimens is remarkable. Many of them have been converted into phosphate of lime. They are as perfect as if the animals had only recently died. The canine teeth show the surfaces which were rubbed down by carnivorous use—the molar teeth of herbivorous mammals bear strong witness to the wear and tear produced by the extinct vegetation on which these animals fed. Some of these caves are perfect cemeteries of Miocene mammalia. Even a non-geologist cannot help seeing what a wonderful difference there is in the appearance of these fossil teeth and those of any existing animals. The naturalist is perfectly bewildered by them, for he hardly knows to what kind of creature he shall assign them, on account of their partaking in many instances of the characters of three or four different classes of living mammalia. In one of these store-houses of antediluvian natural history jaws and teeth could be picked up at the surface. Hitherto these early Miocene mammals have occurred singly, and a tooth has been considered a treasure. Guess, therefore, one's astonishment at seeing in the little parlour of the Mayor of Bach—a small village near Limogne—more bones and teeth of early Tertiary mammals than are to be found either in the British Museum or in that of the Jardin des Plantes at Paris! Some of the teeth must have belonged to gigantic animals, for there were canines four inches in length.

It is not uncommon to find the bones of animals along the floors of caves, or mixed up in what is called "cave earth," and it is now acknowledged that for the most part both bones and earth have been conveyed there from the surface by the action of water. If the reader were to witness the rubbish carried by the water, especially after a heavy rain, which finds its way down the "swallow-holes" so frequent on the limestone in the neighbourhood of Clapham and Ingleborough, he would not wonder at deposits of bones and earth occurring in underground caverns. Many caves have undoubtedly been sheltering places for wild animals which brought thither their prey in order to comfortably devour it, so that bones have accumulated in this manner also. Kent's Cavern, near Torquay, is an ancient hollow thus frequented by pre-glacial mammals. In the south of France are numerous caverns whose floors are thickly paved with bones of post-glacial creatures and the remains of primitive man. As a rule these cave floors are very hard and solid owing to the stalagmite having covered up the bones and earth and cemented the whole into a kind of breccia. To the naturalist these cave-bones are very useful, as they enable him to assign the date when the caves were already formed and in use.

This is the case with what we may call the phosphorite caverns. They are in reality early Miocene caves, which communicated with the dry-land surface during the earlier part of the Tertiary epoch, just as existing caverns communicate with the surface nowadays. Miocene mammals either lived in them or had their bones carried thither by some such action as that of water rushing down "swallow-holes." The jaws of some of the fossil mammals are so fragile that one is forced to believe their owners must have lived in these caves and died there. The commonest animal whose bones and teeth are thus met with are those of the *Palæotherium.* This was a harmless, herbivorous, tapir-like creature, first described by Cuvier. Its remains are not only abundant, but in the finest state of preservation. Associated with it is a kindred extinct animal whose harmless nature is indicated by its name of *Anoplotherium.* A large rhinoceros-like creature, called the *Acerotherium,* formed a prominent figure among the group; and by many geologists it is believed to be the original hornless ancestor of all the species of rhinoceros. Whilst referring to the fossil remains so plentiful at Bach we must not forget those of the *Cricetodon.* These were chiefly small jaws, having teeth of an insectivorous character. Associated with them were teeth and jaws of *Cynoictis,* a creature related in some measure to the racoons and weasels. The remains of the *Hyænodon* were met with more or less abundantly, and from the worn character of the crowns of the teeth the terrible uses to which they had been put were made evident. The *Hyænodon* was in all probability the ancestor of the modern hyæna, and possibly of other generic types of carnivorous animals as well, for the singular feature about these ancient mammalian forms is that they are veritable "missing links," and possess distinctive zoological characters which are now shared among half a dozen generic types. The peculiar feature about the jaws of the

Hyænodon was that instead of having only one cutting tooth, or canine, on each side of the jaw, as all modern carnivorous animals possess, it had three. The teeth of the upper and lower jaws worked together like the blades of a pair of scissors, and proved about the most terribly developed kind of weapons with which any feline animal was ever equipped.

The remains of a very large mammal were more sparsely distributed through the cave earth. We found them chiefly as teeth, although it is more than probable that several huge bones belonged to the same creature. Geologists have given to it the name of *Anchitherium*. It was evidently an herbivorous animal, and is believed to have been hoofed. The *Anthracotherium*, whose bones and teeth were also found, is described as having affinities with the river hogs on the one hand and the hippopotamus on the other. That many of the bones thus found so abundantly had been carried in by running water was proved by the remains of crocodiles. Scutes or scales were not rare, and an anatomist would doubtless have also discovered the presence of this reptile in some of the fossil bones. Among the teeth are those of the *Deinotherium*, an animal which has yet furnished to naturalists no other part of its skeleton than the head ; and so in pictures of it the reader will see the creature reposing, its limbs carefully tucked out of sight, for the simple reason that geologists know nothing about them. There is, however, good reason for believing that the *Deinotherium* was related to the sea-cows, such as the manatee and dugong, which now frequent the mouths of large tropical and sub-tropical rivers. Besides the above, there are numerous remains of such extinct animals as *Xiphodon*, *Amphicyon*, Bats, large Serpents, etc.

It is needless to give a further catalogue of the strange creatures whose teeth and bones lie commingled in this ancient French burial-ground. The reader will have seen how unlike they are, not only to any existing animals, but particularly to the fauna of the district. We know that the mean temperature of the climate has altered since that distant period sixteen degrees at the least. We found no remains of plants; but the flora of the early Miocene age is even better known, from what has been discovered elsewhere, than its animals. Doubtless many of the bones have decomposed, and thus been removed altogether. Indeed we found them in every stage of decomposition; and perhaps it is only the chemical change which had replaced, particle for particle, phosphate of lime for carbonate of lime, that has helped to protect and preserve so many. In some caves and gorges very few traces of animals are met with, and then only as portions of teeth. These, however, are of the same kind as those above described. Singularly enough, in those caves where the phosphorite was thickest and richest, the bones and teeth were fewest; and where the fossil bone and teeth were plentiful, the phosphorite was poorest. This rule is so invariable in its occurrence, that the miners do not like to find plenty of fossils. This looks as if the phosphorite represented the dissolved phosphate of lime, which the absent bones and teeth contained, whilst the fact of the fossils being present shows there has been no such dissolution, and therefore little or no phosphorite could be formed.

Another page in the history of our earth may be read all the more clearly from the investigation of places like these ancient French caverns. The dry bones exhumed from them live again under the constructive skill of the comparative anatomist. Even the soft fleshy tissues with which these skeletons were clothed have not altogether eluded us. In the many changes they have undergone they are yet manifest to the chemist and the geologist; and these very phosphates, now so valuable to mankind as fertilising manures, are the result of the decomposition and recombination of organic matter of some sort, to which the ancient skeletons have largely, if not wholly, contributed.

CHAPTER III.

SUBMARINE FORESTS.

LET it be assumed that some of our readers have wandered along that *terra incognita* to Londoners—the Norfolk coast. The journey is anything but cheerful. Near Yarmouth the shore is skirted by a low and undulating ridge of "marram" hills, so called from the particular species of grass whose roots partially bind down and hold together the otherwise shifting sand-dunes. Besides this there is little herbage, and that of the most meagre description. The landscape is nearly as bleak as it is possible to suppose one can be. Here and there maybe, at various distances, squat a few houses, built principally of drift-wood or old boats, much after the fashion which Dickens has described in *David Copperfield.* These are chiefly fishing villages or settlements. The most noticeable feature about them is the general absence of the male kind, who are absent on their fishing expeditions, and whose numerous yawls and trawling-vessels scattered over the sea hard by relieve the silent monotony of the landscape. This German Ocean is the piscine harvest-field of the Metropolis, and generally of England. It is exceedingly shallow; for there are parts where hardly twenty feet of water exists. Dangerous sand-banks dot its surface, whose neighbourhood at high tide can be easily told by long lines of white breakers. Between them are navigable channels, the deepest of which is about sixty yards. This is known on the charts as the "deep-water channel," and its course is more or less parallel to the coasts of Essex, Suffolk, and Norfolk. Fringing every spit of sand are shoals of cod, haddock, turbot, plaice, sole, etc., all of them greedy to prey upon the mollusca which there find a suitable habitat. The open sea is the haunt of the herring and the mackerel, so that the fishing navy is naturally divided into the two classes whose business it is to seek ground and surface fish. The busy scene seawards always provides the spectator with sufficient objects. The vast numbers of trawl and herring boats, and the fleets of Newcastle colliers, make it more lively than any other portion of the British seas. This fact, coupled with its dangerous character, accounts for the thick cluster of black dots, which, in each year's wreck-chart, indicates where vessels have gone to pieces.

Proceeding northwards from Great Yarmouth, past Caistor, Somerton, and Winterton, as the pedestrian approaches Happisburgh he finds a change taking place in the coast landscape. The last memento of the sand-dunes is old Eccles Church, buried in the drifting sands, with the exception of the upper portion of its round tower, which peeps out like some antediluvian well stripped of its extraneous covering. A good example this of the waste of our Norfolk coasts, which has been going on for ages. From this spot there commences a long line of bold cliffs, composed chiefly of a stiff blue clay, capped by sand and gravel, known to geologists as the "lower glacial beds" or "drift." This bold range of cliffs continues to beyond Cromer, and is never lost sight of; alternating in height from thirty to one hundred and twenty feet. An occasional church with an unusually high tower, made to do duty in the olden time as a landmark, and pairs of white lighthouses, intended to direct navigators through the intricate labyrinths of the sand-banks, are nearly all the traces of human presence the spectator can see from the shore. At low water the sandy beach extends outwards for miles; proof of the shallowness of the sea. At the proper season it would almost seem as if a human population had sprung into existence by magic; for carts and horses, men, women, and children, are thickly strewn over the shore collecting cockles and mussels, or busy shrimping. But this peaceful scene, with the German Ocean gently rippling over the sands and lapping the base of the tall cliffs, is transformed into a fearful spectacle when a north-west gale has blown for a few days. Then we have the secret of the shallowness of the adjacent sea, as well as of the origin of its dangerous sand-banks. The waves rise to a fearful height, and dash against their barriers with a violence hardly excelled in the most dangerous seas of our globe. The soft clay masses are eaten away, and then the strata overhead fall down with a shock like to that of a small earthquake. Not content with this wholesale destruction, the hungry sea hurries away its spoil and distributes it along its floor. Quantities of the waste are piled up by currents as shifting sand-banks, or are thickly silted over the beach. The disintegrating power of these storms may be guessed at by the fact that boulder-stones of nearly a ton weight are washed out of the cliffs, and rolled by the billows miles away from land. These boulders the trawler fears beyond measure; for if once his drag-net gets entangled with a specimen, his profits are gone for many a week to come. Some parts of the sea-bottom are actually unfished on account of the quantity of these dangerous obstructions lying along it. Meantime the dry land is slowly wasted away on an average of several feet a year. At Happisburgh may be seen rows of houses, formerly inhabited by the coast-guard, all standing solitary and untenanted near the verge of the cliff. The surface of the land, nevertheless, is rich and fertile, and man clings to it as long as he can. But the farms fringing the coast are generally let on short leases and on annually decreasing rents.

Cropping out along the feet of these cliffs is a geological phenomenon possessing intense interest even to a non-scientific reader. It is neither more nor less than an old Forest-bed of immense antiquity. After one of the north-west gales already mentioned, there may be seen extensive patches and sheets of semi-indurated mud and turf which extend to the very margin of low water, and continue beneath it seawards for miles. This is the soil upon which the old Forest grew, and the vegetable exuviæ it left behind. When examined, it is seen to contain hundreds of the stools of trees, some of them three or four feet in diameter, and each with its roots spreading into the surrounding mud. This old Forest-bed has been traced as far from Cromer as Southwold in Suffolk, a distance of nearly forty miles, whilst its accurate landward and seaward extensions are unknown. That it forms no small portion of the floor of the German Ocean there can be little doubt. Fishermen are constantly dredging up portions of its vegetable soil, its old gnarled tree-trunks, and its numerous mammalian remains. Underneath the sea hereabouts is one of the most striking evidences of an old land-surface known to geologists.

Were this sea-bottom to be upheaved only forty yards (a mere trifle compared with what has taken place since the forest grew), then the whole of this strange phenomenon would be laid bare. Owing to the shallowness of the sea, dry land would stretch away from Flamborough Head to Heligoland and Jutland. Norfolk would once more be connected with the great Germanic plain, and England become a westward prolongation of the European continent. The "deep-water channel" skirting the eastern coast would, under such circumstances, become the course of the Thames and its tributaries. Such a change would, in fact, almost restore to us the terrestrial conditions which existed when this now submarine Norfolk Forest-bed flourished.

The geological age of this phenomenon is pre-glacial; that is to say, it dates before the period of intense cold, when an arctic climate replaced our own, and before Great Britain had last sunk beneath a wintry sea, all but the tops of her highest mountains. The present cliffs under which the buried forest extends, since the latter rejoiced in its arboreal glory, have been formed as an immense mud-sheet along the bottom of that glacial sea. The huge masses of sand, gravel, and clay strewn over the Northern hemisphere down nearly to the fortieth parallel of latitude, have all been elaborated since the Norfolk submarine Forest ceased to exist. Our mountains have been sculptured by inorganic forces into their present shapes, many of our valleys have been eroded into their prevailing fertile and smiling conditions, old continents have gone down like foundering ships, and new seas overwhelmed their areas, since this Forest-bed was transposed from its superficial condition. And yet, geologically speaking, these vast changes are hardly to be compared to the mighty events which took place in ages long antecedent.

The most striking peculiarity about this Forest-bed is the extreme contrast between its animal and vegetable remains. The latter, with one or two exceptions, almost exactly resemble the present flora of Great Britain; whereas the former are utterly unlike any animals now living in these islands. All the geological changes above referred to have therefore taken place within the lifetime of existing species of plants and trees. Elsewhere in this country we have manifold evidences of old land-surfaces. Our coal-fields are full of examples; and the Portland "dirt bed," of later date, with its petrified trees allied to tropical forms, is a later illustration. But in the Norfolk Forest-bed we have evidence of a temperate climate very similar to that now enjoyed by ourselves; as well as striking proofs of our former continental prolongation. A close examination of the upper soil of this old Forest, which is matted into thin layers, reveals the presence of innumerable wing-cases of beetles, *fresh-water* shells, etc. It certainly is singular to find fresh-water strata forming the floor of the sea.

Among the stumps of trees so plentifully dotting the black surface are chiefly the Scotch and spruce pines, and branches, roots, and leaves of yew, willow, alder, oak, sloe, and hazel. The matrix is frequently of a *turfy* structure, and in its dark appearance shows the presence of a great admixture of vegetable matter. Its entire suite of arboreal remains reminds one strongly of the adjacent Norfolk land-surfaces, and extensive muddy marshes. The most advanced opinion relative to this Forest-bed is that it is the site of an old marsh, rich in the various mineral elements necessary to a luxuriant vegetation. The fresh-water shells and other remains certainly bear out this idea, which is further supported by our finding such fossil plants as the buck-bean, the yellow and white water-lilies, hornwort, pond-weed, etc. The occasional occurrence of marine and brackish water shells shows that the sea was not far distant, and tells how its waters made periodical excursions over the low-lying portions of the area. In fact, the various circumstances attending the deposition of the vegetable remains indicate conditions exactly like those of everyday life. Hazel-nuts are found perforated by weevils, fir-cones are bitten away as if by squirrels, and even the gum which exuded from the pines may be met with as so many lumps of resin, just as in older strata in the Baltic it is found as amber. The water-lilies bloomed and seeded, although possibly human eyes were not opened upon the smiling earth for ages afterwards. The stagnant pools were faintly streaked and rippled by "spinners" and other water-beetles. Judging from the fineness of the mud or soil, it must have been a long time in process of formation. At Cromer the stratum attains its greatest thickness, which never exceeds a few feet. Here also one meets with the greatest quantity of vegetable remains. At Runton, a little farther along the coast, the soil of the Forest-bed expands into a thick fresh-water deposit. The only tree not indigenous to Britain whose trunks and cones are found is the Norway spruce-pine. This is a native of a colder climate than our own, although we have naturalised it in this country pretty easily. The Scotch fir, also abundant in the same bed, has been confined within historical times to the land whence it takes its name. Our then connection with the Continent, however, will explain how such northern trees grew in English latitudes; whilst the subsequent submergence of Great Britain during the Glacial epoch, is sufficient to indicate the causes that exiled them until they were reintroduced. It is well worth the while of the geological student to visit these wild and solitary Norfolk coasts, especially after a long-continued north-west wind. If he go at any other time, he must take his chance of finding any portion of the Forest-bed visible. The waves have an immense power of silting up, as in stripping off, their own work. As the sea is constantly gaining on the land, after every storm more severe than usual, new sets of sub-fossil trees are constantly being brought to light. A better indication than this could not be wished for, of the persistent character of the old Forest, as well as of its landward extension.

Familiar and matter-of-fact as are these floral details, so that they seem to differ little from what we should find in any extensive peat-bog in our own times, the difference is more than atoned for by the associated animal remains. These are met with both in the Forest-bed proper and in an overlying stratum, which has earned for itself the name of the "elephant bed" from the large quantities of teeth and bones of that animal which have been disinterred from it. Thanks to the researches of the Rev. John Gunn, the mammalian remains of the Forest-bed are now pretty well known. Elephants of at least *three* species have been exhumed, the largest of which, according to the late Dr. Falconer, was not less than sixteen or seventeen feet high. The tusk of one of these animals has been dug out, and although nearly three feet were broken off, it still measures ten feet in length, and is nearly three feet in circumference. The other animals known are a species of horse, much larger than the biggest Suffolk cart-horse, together with abundant remains of tiger, bear, hippopotami, rhinoceri, and beavers (nearly twice as large as any now living), deer, oxen, goat, water-rat, fresh-water tortoises, etc. Many species of these animals were of unique form. One kind of deer, named after the veteran geologist Professor Sedgwick, had antlers extending six or seven feet on each side the head, and four feet in height. The remains of one "missing link" in the animal world have turned up in this deposit, connecting the ox with the deer, its horns or antlers possessing characters common to both. Such is a brief outline of the fauna of the Norfolk Forest-bed. It existed long before the German Ocean had cut its way through the boulder clay and occupied its present site. It is difficult indeed for one to associate an English forest with the heavy tramp of browsing elephants, or English rivers with wallowing hippopotami and rhinoceri. And yet here are evidences of the marsh and perhaps the delta of an old river certainly as vast as the Rhine. In it we have evidence of huge beavers building their dams and seeking their finny prey. Herds of deer were attracted by the luxuriant vegetation and the fresh sprouts of familiar shrubs. Wild horses galloped over the bleak chalk plains of Norfolk and Suffolk, and goats and oxen wandered as their nomadic appetites prompted them. Under the German Ocean, with the exception of that portion stripped off by its fierce currents and strong tides, lies the great sepulchre of these pre-Adamite animals. A semi-hardened soil, containing freshwater shells and land and aquatic plants, is the floor over which one of the most dangerous seas in the world storms and tumbles. The pre-human epoch is brought into contact with the present in strange affinity. Many a goodly ship has found a resting place on old-forest ground, and the bones of brave mariners who fought hard for dear life lie commingled with the remains of old-world elephants, hippopotami, rhinoceri, and bears.

As an indication of the numerous bones and teeth which have been washed out of the original matrix of the Forest-bed, we may here mention that altogether many thousand elephants' teeth have been dredged at various times from the sea-bottom by Norfolk fishermen. In addition to these have been found great numbers of fossil tusks, etc., many of them covered with marine worm-tubes, oysters, and anomia. At Bacton remains of the narwhal, walrus, and the common whale have been met with. Their occurrence proves that, towards the conclusion of the Forest-bed period, a gradual change of level had commenced, during which these animals were stranded and their bones entombed. This submergence, it is known, went on until a tolerably deep sea spread farther and farther inland, and eventually all but the tops of the high hills in Great Britain were covered by it. Of the time taken up by the process, we can form little idea in actual numbers of years. But we have their result in those superficial deposits of sand, gravel, and clay, so necessary to agricultural wealth and prosperity, and without which England would have been in a very different state from what she now is.

Under the German Ocean lies one of the latest chapters in geological history—an epitome of old-world animals and plants, many of them the direct ancestors of existing species—the details of whose former humble life may be read off as plainly as antiquaries have deciphered the manners and customs of ancient Herculaneum. Just before the great ice-sheet swathed northern continents, we catch a glimpse of peaceful English forest-life hardly differing in its floral character from that of to-day, although scores of centuries have meantime rolled away to join the mighty host which preceded them.

Not far from Cromer and Overstrand, near Happisburgh, and at Hunstanton, on the Norfolk coast, is another submarine forest, but of quite a different geological date. We have already seen that the Cromer Forest-bed was *pre-glacial*—that is to say, it grew before the strange physical change took place which wrapped Great Britain—and, indeed, most of the northern hemisphere—in a winding-sheet of ice and snow, similar to that which now invests Greenland. These arctic conditions extended, maybe, for scores if not hundreds of thousands of years, if we are to judge by what took place in the interim. It was *after* this rigorous northern winter had passed away, that all our other British submarine forests grew. The latter are therefore called *post-glacial*. When they flourished, the great Germanic plain now occupied by the waters of the German Ocean was low-lying dry land, where herds of hairy elephants (Mammoths) wandered amid a continuous scrub-forest of dwarf oak, alder, and willow. Through this level plain the Thames poured its waters—along that continuous valley marked on the Admiralty charts as the "deep-water channel." Farther to the north it may have even been joined by the Rhine, the two forming a stately river, which debouched into the North Sea. The latter has been a sea for ages, as its depth of 600 fathoms plainly shows. Along its floor exist marine creatures which, before the days of deep-sea dredging, were supposed to be extinct, their remains having been found only among the numerous fossils of the "crag" strata, or even in the chalk On the other hand, an elevation of only 120 feet, if it took place under the German Ocean, would once more convert the latter into dry land. But it is evident that this upheaval, great as would be its geographical influence over the German Ocean bed, would hardly affect that of the deep North Sea, or the habits of the marine creatures living on its bottom.

A line of soundings shows that the floor of the German Ocean is comparatively shallow as far as the "Dogger Bank," off the Northumberland coasts. The old Thames valley to which we have referred hugs the outline of the English shores all the way, and here and there we have deep holes that may have been lakes when this sea-bed was low-lying marsh-land. Over an immense area the dredging-boats are constantly bringing up peaty soil, showing that the bottom was once dry land. The remains of post-glacial animals are also frequently brought up.

A collector at Yarmouth bought all the bones and teeth which the fishermen lately dredged up, till he was tired of purchasing; and his collection now shows tusks and teeth of the elephant, grinders of the hairy rhinoceros, antlers of deer, etc., in profuse abundance. These have all come from the adjacent shallow sea-bed, and chiefly from the *post-glacial* forest, although some of them are undoubtedly from the *pre-glacial* submarine forest at Cromer, already referred to.

It is difficult to reach the Hunstanton forest without the assistance of a boat, so far does it lie out to sea. About a couple of miles from high-water mark you come upon the submerged forest, full of trees, trunks, and branches, all of them so soft that they yield to the pressure of the finger. In this respect the Cromer trees are much harder, and more full of iron sulphite. The black peat, in which the trees lie, is composed of matted leaves, twigs, bog-moss, etc. It was once inhabited by herds of deer and wild oxen, as is evident from the abundance of their remains. Nay, savage man seems to have also been a denizen of these "wild woods," for a flint celt, or stone axe, was found imbedded in one of the submerged trees.

Nearly all our estuaries appear to be underlain by these ancient forests. Mr. Lucy, F.G.S., has recently described one under the Severn, twenty or thirty feet beneath the present level. Within the last few years we had occasion to draw attention to one beneath the river Orwell, in Suffolk, which extends down the old valley from Ipswich, for a distance of six or seven miles. The river channel, at low water, is partly excavated out of it. We dug through the compact bed of peat, which now represents it, for a depth of seven feet, until we came upon the ancient soil on which the forest formerly grew. The upper part of the forest-bed was crowded with trunks of beech, scrub-oak, and hazel, and was composed chiefly of matted leaves, so perfectly preserved that every vein could be seen, and all the leaves identified.

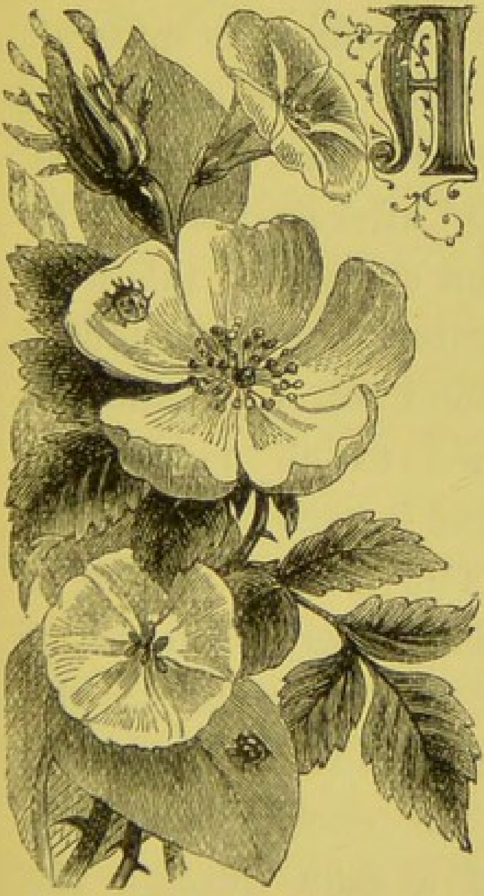
Coming farther south, we find a submerged forest, evidently of the same age as the two last mentioned, underlying the Thames. At various places between Woolwich and Erith the remains of this interesting deposit may be seen at low water. It is overlain, in the marshes, by six or eight feet of alluvium. When dug into it yields abundance of stools and trunks of trees, leaves, etc., as well as remains of the red deer, and long-fronted or native ox. At St. Leonard's, near Hastings, the remains of another submarine bed are to be seen at low tide. Farther to the south at Bracklesham, and to the south-west in Torbay, we come upon others, which seem to lie in deeper water than usual. At Lyme Regis, Porlock, Minehead, Weston-super-mare, Sharpness, Millendreth Bay, Falmouth, Barnstaple, Bideford, Holyhead, Morecambe Bay, and elsewhere, are visible many other "forests under water." The description of one, as regards the trees, leaves, and plants, and also the associated animal remains, would nearly answer for all.

One needs little geological knowledge to perceive that when this extensive fringe of submarine forests grew, the land occupied by them must have stood higher than it does now. The question remains—Did it stand high enough to convert what is now the shallow German Ocean and Irish Sea into dry land? Geologists believe it did, and that the peat-bed and Mammoth remains lying along the floor of the latter are pretty much of the same age as the submerged forests. Of the two they are older, and these old woods may have grown when the depression was slowly going on which ultimately transformed the low-lying marshes of the Germanic plain into a sea-bed. That the geographical separation of England from the Continent, and of Ireland from England, is one of the most recent geological phenomena connected with these latitudes, all scientific men are agreed. Not only does the fringe of ancient forests surrounding the British Islands indicate this, but it is further supplemented by the animals and plants which still live among us. All our native species are identical with those found on the mainland of Europe. Our mammals, birds, insects, fresh-water fish, and mollusca, land and aquatic plants, are the same as may be seen on the other side the German Ocean. They must, therefore, have naturally spread over what is now Great Britain before the depression took place which converted the latter into a group of islands. The similarity of the trees, plants, shell-fish, and animals found in our submarine *post-glacial* forests to those on the dry land tells plainly of the former connection of fauna and flora, and indicates how it was broken. Here, therefore, we catch a glimpse of primeval England, shivering in a less warm climate than the present, perhaps partly on account of the absence of the Gulf-Stream influence before she became an island. She is clad in woods and forests even more dense than those described by our earliest historians—a continental prolongation, with Ireland, into the unknown Atlantic. Savage man contends for the mastery with bear, and wolf, and hairy Mammoth. The flat, boggy, Germanic plain becomes marshier; the North Sea laps farther and farther to the south, and so gains upon the morass as the depression goes on. The Atlantic has already assumed the sovereignty of the low plains of the Channel, although it did not wash over the Irish Sea until some time after. The "strip of silver sea" gains with the centuries, until the isolation is complete, England has become an island, and Ireland has followed the example even before the faunal migration has extended to the western verge, leaving behind species of reptiles and mollusca, abundant on the east side of the German Ocean, less so on the English, and not at all represented in the sister island. No other geological phenomena in our Islands so powerfully bring out the vividness of Tennyson's well-known line :—

"Now rolls the Deep where grew the Tree."

CHAPTER IV.

HUNTING FOR MINERALS.



AMONG the thin fissures and hollows of the Carboniferous limestone rocks of Derbyshire there usually occur crystals of various minerals. Sometimes the deposition of these has gone on along both walls until the fissure has been completely filled up alternately with sparry and metallic matter, thus constituting a "metal lode." Very frequently, even in hand specimens, one may see crystals of a certain geometrical form covered by those of a later deposit; thus indicating that, when the first were formed, they must have been *outermost.*

Lower down, the unfilled and larger fissures are taken advantage of by natural drainage; so that we frequently find them constituting the subterranean beds and courses of rivers or streams. This continued for ages, and, meantime, they were widened by chemical dissolution and erosion. Then, perhaps, has come more or less of an upheaval, which caused the waters to flow at a lower level, and so to leave their former passages as long winding caverns. Into one of these, some years ago, we rambled, with the determination to get as far as the passages would allow us, in order to seek for certain rare minerals which were reported to be found. The main part of the cavern had been discovered after many years' stupid and blundering "driving" after lead-ore. The passage or tunnel had all been cut out in this way. This very remarkable semi-natural phenomenon is situated in the neighbourhood of Castleton, in Derbyshire—a locality known to all readers of Scott's *Peveril of the Peak*—and it goes by the name of the "Speedwell Mine." The scenery around is truly magnificent, more especially near the mouth of the cavern, which occurs at the entrance to the "Winnats" or "Portal of the Winds," as the word signifies. The Winnats is an enormously wide fissure, extending above half a mile through the solid rocks in the manner above described. No matter however still or sultry the summer day may be, we are sure to meet with a gentle breeze winding along this mountain-pass.

The entrance to the Speedwell Mine is by a door in the hill-side, which strongly reminds one of that mentioned by Bunyan in his *Pilgrim's Progress*, as shown to Christian by the shepherds. In at this door, one starlight night in February, we entered, each laden with a suit of miner's clothing wherewith to equip ourselves for our adventure. We speedily converted the small cottage hard by into a dressing-room, and turned out in a manner that would certainly have surprised our friends.

Entering by the door at the hill-side, we descended a flight of more than a hundred steps ; when at the bottom, to our great surprise, we found a boat ready to row us along a subterranean passage, in which was about four feet of water. There was just sufficient room to sit upright in the boat without knocking our heads against the top ; and along this passage we sailed for the distance of nearly half a mile, lighting our way as we went by sticking candles against the sides, by means of balls of soft clay. When we had proceeded for some distance, we were requested to look behind us ; and the reflection of the lights in the still water was strikingly beautiful, reminding us of a long narrow street lit up by gas. This is the main passage, which was literally hewn out by the muscle and sinew of the miners in their search after lead, and we could see one or two thin veins of that metal crossing the roof of the passage transversely.

The stillness at first was almost unearthly, and it seemed to be exaggerated when we remembered it was night ; but by and by we could hear a faint droning sound. On asking whence it came, we were told, to our astonishment, that it was caused by the water over which we were then sailing falling over a cataract into the "Bottomless Pit." As we proceeded, the noise increased, until at length we had to speak in a different note in order to hear one another. We were so completely interested in the uproar that we did not notice the boat had stopped until one of the company drew general attention to it. A large rock had impeded our course, and to it we moored the boat and landed. Raising our candles above our heads, we perceived we were in a mighty cavern, whose darkness our feeble lights only seemed to render more obscure. On each side, high as we could look up, huge rocks hung over, as though ready to topple on our heads with the least disturbance. But the sight was inexpressibly grand, when, after lighting a rocket, the hissing blazing torch mounted upwards for more than one hundred feet, without even then reaching the top. As it ascended, the darkness below became more and more palpable ; and the dazzling light above our heads revealed a similar arrangement of rock-masses to those we could see around by the faint light of our candles. The whole effect was most striking, and had much of the character which Martin has thrown into his weird picture of the "Great Day of His Wrath. We shall never forget it. The sight has haunted our dreams scores of times since.

We now turned our attention to the falling volume of water as it dashed over the precipice. The latter is protected by an iron railing ; and a dazzling magnesium light held over showed us a black yawning chasm, into which the seething waters were hurrying themselves. We could not see the bottom, although it is known that a communication exists between this cavern and the Peak, more than a mile away ; for sawdust thrown into this stream has been carried out by the rivulet which flows from the mouth of the Peak Cavern, or Devil's Hole. The sights above mentioned are those ordinarily shown to visitors ; but as we passed along the main canal, we had noticed several small passages branching out on our right hand, and now we returned to make our explorations in them. They had not been entered for nearly thirty years, so that there was a little spice about the adventure. We were each armed with hammers—geological indispensables—and in our toilet of miners' clothing were well prepared to rough it. So in returning we stopped at the mouth of the right-hand passage called the "Half-way House," and fastened the boat firmly to the rock ; for had it chanced to drift away, we should have had a quarter of a mile to wade through a stream four feet deep, whilst the owner would have had to perform the same feat right to the other end to bring it back.

As we got out of the boat, we had above a foot of water to wade through for about a hundred yards, along a narrow and dripping passage which cramped our backs with the bending. We were relieved at the end by being able to stand erect in a vast rent in the rocks, extending so far above our heads that the dim light of our candles did not enable us even to guess its height. Between the walls of this fissure —which was about three feet across—bars of wood had been placed to serve as staves ; and so, fastening our hammers in our belts, and sticking our lights in our hats, we mounted up one after another. This was a somewhat dangerous task, for the wooden bars had been there so long that they had become rotten from moisture ; so if the leading man had made a false step and tumbled down, he would have sent us all before him like a lot of skittles. At last, after ascending some hundred feet in this way, we reached the top, and found a passage similar to that along which we had waded extending in a westerly direction. Along this we made our way with bent backs, and at the risk of breaking our shins over an old wagon, which had been left there by the miners years before. Here we could see the lead-vein crossing the path, the matrix in which it occurred being filled with "cawk," or sulphate of barytes in an uncrystallised form. Farther on, the passage was so narrow that we had to crawl on our hands and knees among mud. All this labour, however, was abundantly compensated by discovering that a little farther the masses of rock were covered with pyramidal-shaped crystals of calc spar. Most of them had the appearance of having been dusted with large granules of loaf-sugar, owing to the smaller crystals which had been formed upon them. As we passed along, the crystals reflected the light of our candles like so many lustres. Farther on we found the rocks still covered with similar crystals, but among them were perfectly sky-blue cubes of fluor-spar. These were among the rarities we were in search of. We obtained some magnificent specimens, the most curious being a dog-toothed crystal of carbonate of lime, with a little blue cubic crystal of fluor-spar balanced on its very apex.

All this time we were cramped in a doubled-up posture, and in this condition we had to knock off the specimens. Presently, however, we found the narrow passage opening out into a capacious natural hollow or cavern, from the top of which were pendent hundreds of beautiful snow-white stalactites. Along one side the same mineral had coated the walls and upholstered them as with folds of petrified drapery. Standing out in relief on the naked rock were numerous fossils—long jointed stems of encrinites, shells of spirifera, orthocera, and a host of other extinct organisms, which had not seen the light since these rocks were deposited as limey mud along the bottoms of the Carboniferous seas. The floor of the cavern went aslant, and we made our way along it.

There was a little passage on one side through which we could creep one at a time, and so we wriggled our way through to see what lay behind. And if nothing else had repaid our labour, certainly the sight of the magnificent cavern into which we now entered did so most amply. Not only for its splendour, but also for its size, it was unequalled by anything we had before seen.

When we had all got together, we looked round us, and were deeply impressed by what we beheld. The wide vault, hidden by the blackest Egyptian darkness above our heads, and the masses of rock strewn around, made us feel like pigmies. The effect was more striking still when we burnt another magnesium light; for it threw out the light and shade of overhanging masses into splendid relief. The huge stalactites, the massive folds of stalagmite which mantled the faces of the rocks, the thousands of crystals of various shapes and colours which reflected the dazzling light in as many coruscations, made us almost speechless with wonder and delight. After attempting to make our way in other directions, we had to give up, owing to the passages narrowing so much as to prevent us even worming ourselves along, else there is no doubt we might again have met with caverns as capacious as any we had seen. In fact, all the hills hereabout are quite honeycombed, and the subterranean passages extend for miles, widening and narrowing alternately as they run along.

But four hours in the heart of the mountains, accompanied by wet feet and clothes, were not so pleasant as to hinder us from returning. This feat was not without its difficulties, as may be supposed, especially when we came to our last foe, the ladder. Descending it in safety, we found our boat just as we had left it; and another quarter of an hour brought us under the clear midnight starlight.

CHAPTER V.

SOILS: THEIR ORIGIN, RENOVATION, AND DECAY.

WITHOUT intending a pun, it may be safely said that this is a subject which covers a great deal of ground. There are few other subjects of greater importance, for it has long since been proved by political economists that all wealth comes out of the soil. It gives us day by day our daily bread. It provides us with food whilst living, and a shelter when dead!

The nature and condition of soils are the most important of topics to the farmer. On their composition considerably depends the kind of crops he shall sow. Nature can do a great deal in this respect, and science can do even more. By *science*, we do not only mean the mere theory of soils, but that accurate knowledge begotten of experience. Quite as much depends on the *mechanical* condition of soils as on their composition; and the former, we know, is in the farmer's own hands. According to the way in which he treats it, we know whether or not he deserves that best of praise—"a good farmer."

A great step was made in our knowledge of what really good soils are, when, many years ago, Baron Liebig showed that different crops took up from the soil different mineral substances; that if the soil did not contain the mineral substance, in a soluble form, which a particular crop required, it was foolish to sow it; and that we could give to the soil what it most lacked, or which any special crop required. In short, that plants require food, wherewith to grow, just as animals do, and that their food is contained in the soil. Mr. Coke, of Holkham, in Norfolk, had previously, although without, perhaps, understanding the scientific reason why, discovered the value and initiated the system of "rotation of crops," which simply means that one kind of plant will feed or grow upon substances in the soil rejected by another kind.

The term *soil* is often employed in a very vague manner, although we may regard it as referring to the upper looser surface covering the dry land everywhere. The different soils are popularly denoted by several terms qualifying them; and some speak of them as "heavy," "light," "marly," etc. As to the origin of soils, there is only one source to which we can ascribe them—the weathering and decomposition of solid rocks. In the Eastern, as well as over a large area in the Northern and Midland counties, we have extensive sheets of material which have not been derived immediately from the underlying rocks. On the contrary, these vast beds of sand, gravel, and clay have been brought from a distance, as we may at once perceive by the boulders in them. To geologists they are familiar by the name of the "Drift-beds," and it is known that they actually owe their origin to the action of icebergs and glaciers. Now, the soils in our agricultural counties are nearly all of them derived from the weathering of these drift-beds. No richer source of soils could possibly be mentioned, for our drift-beds have been all formed by the breaking up of rocks of different geological formations and of various chemical constituents. Consequently, the soils derived from the weathering of those divisions of these drift-beds, known as the "boulder clays," and formed by the *wash* along the slopes of valleys, are likely to be much richer in various minerals than soils which have been derived immediately from the weathering of any one kind of rock, as granite, limestone, or sandstone. We see, therefore, that it is primarily this peculiar relationship of the soils to the boulder clays that agricultural fame and wealth of the agricultural counties are due.

The soils produced by the weathering of various kinds of rock are, agriculturally speaking, of very unequal merit. Of course, when we speak of *good* soils and *bad* soils, we always mean those terms to express whether they are beneficial to ourselves or not. Soils which grow an abundance of what we require we compliment by terming *good*. No matter what may be their chemical composition, if they don't grow what we want, and grow the crop well, we call such soils *bad* for that particular crop.

Now, rocks are of various degrees of hardness, and therefore they weather at different rates: consequently, if there be an entire absence of those drift-beds to which we are so much indebted, we should find a very thin layer of soil over such underlying rock as, say, hard slates. Slate rocks usually occupy hilly districts, and there, owing to their superior hardness and the greater slope of the ground, the accumulation of soil is prevented, for the weathered particles are apt to be washed down to a lower level as fast as the hard rocks are decomposed. If not carried directly away by rivers, such detached particles will gather in the valleys which wind among the hills, and there, as every traveller knows, are some of the bonniest, greenest, and most fertile spots in the world!

There are various areas in Great Britain where granite crops out and exposes its upper surface to the action of the weather. The latter breaks it down into a very light, almost white-coloured soil. It is, however, frequently very barren for all important agricultural purposes, notwithstanding that granite contains some very valuable mineral constituents, such as potash, soda, alumina, etc., derived chiefly from the decomposition of one of its mineralogical ingredients, *felspar*. On the other hand, the marls of the New Red Sandstone in Cheshire, Worcestershire, and elsewhere, weather into rich, stiff, clayey soils, which make excellent permanent pastures, and so they have stamped Cheshire for ever as a "Dairy County." The hard sandstone of the Carboniferous formation weathers very little; although the thick beds of shales it includes disintegrate rapidly, and so form stiff, impervious clays which hold moisture on their surface, and form cold, sour lands.

Nearly every geological formation has its beds of clay in one form or another. Sometimes these strata are of considerable thickness, and then, if their angle of dip be small, they will be found extending over considerable areas of country, and determining the character of its physical geography. Thus, the Oxford clay occupies the greater area of our Fen districts, the Kimmeridge clay underlies the fens of Lincolnshire, and the London clay the marshes of Essex. What a strange similarity in the physical geography of these three different regions, and how wonderfully the agricultural pursuits are determined thereby! These various deposits weather into stiff soils and subsoils when they are uncovered by the "drift" beds, and, although they contain undoubtedly rich ingredients, their mechanical condition does not allow vegetation to obtain there so readily as they require.

We have already said that the *mechanical* condition in which soils are met with is of the utmost agricultural importance. Too much stress cannot be placed upon this. When soils are broken up from the stiff condition in which they occur—for instance, in many parts of the Fen districts—so that the atmosphere as well as the rain can find its way through their interstices, they prove good *cereal* soils. If they are not so treated they must be left as pasture lands—an adaptation which perhaps involves less labour owing to the readiness (often too great readiness) with which the clays maintain the moisture necessary for the permanent growth of grass. Deep draining is nearly always necessary in these sub-clay soils. Even the *colour* of a soil is found to affect its physical character. *Dark*-coloured soils, whether heavy or light, are more affected by the heat of the sun than whitish soils, for the latter reflect both light and heat. Therefore, the germination of seeds must be quicker in dark soils than in any other. Drainage, by carrying off the excess of moisture, allows the land to be warmed by that heat of the sun which, in the undrained state, would be employed in evaporating the surface moisture.

On soils where the remains of insects, the droppings of animals, and the accumulation of decayed vegetation have persistently gone on, there is formed a *humus*. It is the percentage of this which gives the dark colour to a soil. *Humus* contains carbonic acid, and in this state is very useful to plants in enabling them to dissolve soluble mineral matter more readily. In our opinion, one of the best friends of the farmer is the common earth-worm. Its abundance in grass pasture cannot fail to be especially beneficial, for it "top-dresses" the surface by its abundant castings. Now, as earth-worms live entirely upon the organic matter contained in the soil, and in spite of ignorant and prejudiced assertions to the contrary, *never* (for they cannot) attack or devour grass roots, their habit of burrowing underground must be beneficial to the undersoil in allowing free access of air and rain-water; for the roots of plants require nearly as much air as (and even more water than) the leaves. Moreover, when rain-water can thus get down into the soil and be distributed equally throughout it, it can dissolve the soluble salts in the soil, and be itself broken up into vapour by the sun's heat; for the roots of plants require, not water, but *watery vapour*. Indeed, unless water exists in the latter condition it is of no use whatever to plants, but the converse. Plants will actually perish of thirst, even when immersed in water, for want of the conditions necessary to form watery vapour.

Having said thus much as to the origin and physical character of soils, let us next devote our attention for a short time to the causes of their *decay*. Of course this term is understood as implying the uselessness of the soil to produce valuable crops from the seed sown. A very slight consideration will show that the same weather action which forms soils also robs them of their agricultural value. The continued annual rainfall not only dissolves out of the soil a great deal of soluble matter, but must mechanically remove much of the soil itself. Indeed, a glance at the turbulent floods of our brooks and rivers after heavy and long-continued rains, shows us by their yellow, muddy colour that they are carrying a vast quantity of sediment to the sea. All this sediment has been derived from the most easily washed-off parts of the surface soils on which the rains have persistently been falling. It is calculated that the mechanical effect of the rainfall of Great Britain (taking the entire area) would be to lower its surface about one foot in a little more than five thousand years. This is and has been continually going on. Fortunately, however, the *subsoils* are being weathered at an equal, if not at a slightly more rapid rate. Hence, although the general surface may be lowered, there always appears about the same average thickness of actual soil. If there were not a concomitant decomposition of the subsoils, transferred into actual upper surface soils (aided by earth-worms, etc.), the solid rocks would appear naked at the surface, as is the case in mountainous districts, where the wasting away of the soil is more rapid than the rate of decomposition of the underlying rocks. Even the tilling and ploughing of arable land so far plays into the hands of the robbing, weathering action, by enabling it to act more powerfully on the soil, and to waste it in a higher degree than it could have done had it been protected by natural vegetation or by the grass of pasture land.

Hence, it is not merely necessary to put into soils the mineral constituents taken from them by the garnered crops—we must also compensate for that great weather waste to which we are indebted for the very existence of the soil itself. Even supposing we could always give back the exact quantity and quality of the mineral matter we have removed, it would only enable us to farm at a dead level from one generation to another. We may regard it, however, as impossible to replace over any given area the absolute materials which have been carried off in the shape of crops. To put on the manure of animals, even although they have garnered the vegetable produce of a field, is not enough ; for we have to remember that, even if we could replace, when the animals died, the phosphates and carbonates of lime they had abstracted and secreted in their bones, by strewing their carcasses over or working them into the soils on whose grass they had fed, there would still be a large quantity of soluble salts which had been dissolved out of the soil in the meantime, and carried off by brooks and rivers into the sea. We hold it, therefore, to be an absolute necessity in what is called "high" or genuine scientific farming, that so-called artificial manures, and especially phosphatic and nitrate manures, should be employed, not only as fertilisers, but to atone for all the wear and tear and dissolubility of which we have just spoken.

Plants are like animals in this respect—they not only form new tissues, but they *excrete*, or throw off, old and disused ones. And the same kind of plants can no more flourish healthily in a soil charged with such vegetable excretions, than mankind can in a sewage-infected atmosphere. Hence, if the same kind of crop be cultivated in the same soil for several years running, the soil actually becomes poisoned for them by such excreta. One effect of tillage or cultivation is to turn over the soil and expose it to the oxidising influence of the atmosphere, which literally burns it up and consumes it. Not unfrequently it is found when cultivation has been carried on for a long period, or over the same estate (particularly the cultivation of *arable* land), that a hard bed seems to form at a certain depth. These beds are known to farmers by the name of "iron-pans." They require the strongest of steam-ploughs to break them up. Such "iron-pans" have been formed by the insoluble matter contained in the loose soils having been carried down by the percolation of water and precipitated, when much of it was thrown down as an oxide of iron.

The *renovation* of soils must always be a matter of consideration in scientific farming. Everybody can see that the soils may become poorer, but how to more than restore their lost energies demands the most careful consideration and ingenuity. Chemical composition, as well as mechanical conditions, have alike to be studied. It is always easier to lay the blame on the medicine, when in reality the non-beneficial results are owing to the fact that no pains have been taken to know whether it was being administered rightly. Hence we cannot help thinking that so-called scientific agriculture has often been despised by those who thought they were adopting it, but who were utterly ignorant throughout of its first principles. It is no uncommon thing, even now, to hear of farmers buying high-priced artificial manures and putting them on their land, without even enquiring whether they were suitable or not for the particular crops they were anxious to raise! Is science to be blamed for the lack of common-sense that does not know how to take advantage of its knowledge? The greatest benefit which can be derived from soils is that the fertilising salts they contain shall be rendered easily assimilable to the plants or crops grown on them. These salts may be present in the soil abundantly, but owing either to their being in an insoluble state, or to its mechanical condition, or to the soil not being favourable, they cannot be immediately utilised by the crops. For instance, it is found that in very stiff clay lands the mere act of turning over masses of the underlying clay is beneficial; whilst if we *burn* some of this stiff clay and used it for top-dressing it is most advantageous, inasmuch as the burning transmutes the potash contained in the clay from an *insoluble* to a *soluble* condition. Clay, and the iron-oxide which it nearly always contains, have a peculiar effect on the nitrogen which is mechanically mixed with oxygen to form the atmosphere. They absorb more of the nitrogen with which they come into contact than they do oxygen. Nitrogen is a fertiliser—a stimulant to vegetable growth; so that anything which causes the soil to absorb it is so far as beneficial as if we actually put nitrogenous manure upon the soil. We hold that Liebig expressed a greater chemical truth than has yet been appreciated by agriculturists, when he said that crops require very little additional nitrogen, and that good mechanical preparation of the ground would, as a rule, cause the soil to absorb nearly as much as the crops required. Moreover, we have given our reasons in a later chapter for believing that much of the modern plague of *mildew* is caused by *over*-nitrogenising the soils by excess of manures; for it is well known that these microscopic fungi flourish best where nitrogenous substances abound.

In thus speaking, let it be understood that we are only summarising, in the small space at our disposal, some of the most remarkable conclusions at which modern science has arrived. We believe that many of our thoughtful and experienced agricultural readers will find that science is here in accord with their common-sense experience. Of course some soils are very light and poor (as on our "light lands"), and applied there nitrates would be of unquestionable benefit. But it should be understood that *nitrogen* is beneficial not so much because it is an element of growth as because it is a promoter of, or stimulant to growth. It is always present in the growing parts—in the leaf-buds, the young seeds, the terminal branches, etc. *Phosphorus*, on the other hand, *is* absolutely necessary. It is necessary to the reproductive functions, which without it cannot be fulfilled. Hence wheat-corn, barley—all the cereals, indeed—as well as beans, peas, etc. (all of which are the chief ends of crop-cultivation) are highly or lowly developed according to the amount of soluble phosphates in the soils on which they are grown. Even in the secondary crops, such as the "bulbs" of turnips, swedes, beet, and the "tubers" of potatoes, which contain much phosphorus, phosphates are necessary to increased development. The seeds or reproductive parts of our cereal and leguminous crops cannot possibly attain even ordinary development unless a certain quantity of phosphates be present in the soil. Moreover, these phosphates must be *soluble*—that is to say, in the chemical condition which enables the delicate spongioles of the roots of plants to absorb them when they come into contact. This is the artificial condition in which phosphate of lime is sold by the best and most respectable of manure manufacturers. Of siliceous matter there is always quite enough in any kind of soil. Hence the practice of putting *straw* as manure on land is not because the straw contains fertilising materials in itself (for it is almost pure carbon and silica), but because it absorbs nitrogen as manure from the stable or the shippen, and is furthermore of mechanical use when ploughed into the land in keeping it open and pervious to air and rain. Again, when placed on "layers" of clover in winter it protects that delicate and nutritious "stock" crop from the blasting influences of the winter's frost. When phosphatic manures are employed as fertilisers it is necessary to take care that they are placed upon proper soils. For instance, it is almost certain that soils which naturally contain large quantities of iron-oxide (or "rust," as we popularly call it) will precipitate the most carefully-prepared and high-priced of phosphate manures into an insoluble and therefore useless condition. In such soils what is required is *humus*, which is so beneficial in assisting to render the necessary salts soluble. Phosphates, therefore, should as a rule be employed in the ordinary manure, or in association with some nitrogenous substance, which will very largely prevent its return to the much-dreaded and wasteful *insoluble* condition. In this way the nitrogen becomes a vehicle to carry the phosphates safely and without danger of change of condition; and as a rule it will be found that artificial phosphatic manures act best when employed in such combination.

The chief elements, therefore, it is necessary the soils should contain to raise them from an exhausted or depraved condition to one of high fertility and usefulness, and to thoroughly renovate them for all the purposes required by modern "high-farming," are the presence of such soluble salts as soda and potash, and the even more delicately-balanced condition of soluble phosphates. A geological knowledge of the various kinds of soil, and more particularly of the different *sub-soils* which are sure to occur on an extensive estate, may be turned to agricultural value. For possibly the thin, poor, hungry, light soils might be advantageously top-dressed by materials easily obtained where the "chalky boulder clay" occurred; and the too stiff marsh lands might be rendered light and porous by an interchange of sands or other material. Even the peaty soil of a bog may be rendered of high agricultural value by burning it, for it is then reduced to a condition in which it readily absorbs the nitrogen from the atmosphere, as well as acts like a sponge for the retention of liquid or other farmyard manure it is required to put upon the soil. Do not let us be prejudiced. No men have more to learn from modern geology and chemistry than farmers. The light has only just begun to dawn upon us, and the fact impressed upon our minds that the Earth is still an Eden which we are called upon to dress and to keep. No philosophical axiom has ever sunk deeper into people's minds than that it is the highest act of philanthropy to make two blades of grass to grow where only one would grow before! For ourselves, with judicious care and skill we do not see why *a thousand blades* should not be made to spring up in glad juvenescence, actuated thereto by the skill and loving knowledge of the farmer, who, more than any other producer, is dependent on scientific aid and suggestion!

CHAPTER VI.

A NATURALIST ON THE TRAMP (No. I.)

ONE of the most bewilderingly lovely drives or walks in the West of Ireland is that from Westport to Cliefden. The distance is something over forty miles, and the road is tolerably good, although in many places chequered by a good number of ups and downs. If walking, we should recommend the pedestrian to do the first eighteen miles to Leenane, which is, in our opinion, the most beautiful spot to be visited. The road thereto lies over the mountains, and, after gradually ascending three or four miles from Westport, we traverse the surface of a tableland, everywhere boggy and wet, and with pretty loughs or lakes studding its surface. Some of these loughs are very paradises of water-plants, and their margins are covered with the cool green leaves and exquisite white blossoms of the common water-lily. All round this table-land there rises a panorama of hills. Some of them may be called mountains, for they are three thousand feet in height, and their tops pierce the sky, so that the cloud scenery is mapped and patterned by their presence, and produces quite a different appearance from cloud-land in our own parts of the country. These ancient hills have a riven and a weird look, for they are composed of the very hardest rocks known to geologists—namely, the metamorphic rocks. The Silurian sandstones and slates and limestones, most of which once contained organic remains, have been so completely altered by heat that scarcely a trace now remains of a fossil; and yet their geological map—for this country has been geologically surveyed by some of our ablest men—shows the whole region in a variously coloured pattern which indicates how different is the variety of rocks. The white lines on the map, which represent *faults* or vertical crackings and slippings of the solid rock, are exceedingly numerous. Along the line of some of these faults the valleys now extend, for they have proved the weak places where weathering action could be best exerted. The outlines of these grand old hills have been sculptured by Father Time. They are amongst the oldest of our British mountains, and no country in the world has such ancient mountains as Great Britain and Ireland! For millions of years the storms of diverse climates have gathered around these ancient peaks, and have spent their fury upon them not in vain; for it is chiefly to the combined and continued action of the weather that their very shapes are now due.

From the table-land we have mentioned, a peaty brown stream called the Erive makes its appearance; at first so small that a boy could jump across it easily. As we pass along the uneven road, the stream gathers strength from its numerous tributaries, all of them, after a rainy night, seaming the sides of hills like silver threads; and anon it gains in violence and volume and brawls over its rocky bed, which latter widens and deepens as the stream descends towards the sea. Here and there it throws its volume of seething water over some rocky terrace as a waterfall or cataract, and occasionally its restlessness is checked by a deep pool, which the brown, peaty-coloured water makes to appear of unfathomable depth. Everywhere, however, along the route of the stream, even in these elevated regions, there was growing such a wild luxuriance of that most magnificent of all British and even exotic ferns—the Royal Flowering fern (*Osmunda regalis*)—as we have never before seen, except perhaps once along the southern side of Barton Broad, in Norfolk. The tall fronds rise to a height of five and six feet, with their brown spore-bearing branches rustling to and fro in the mountain wind. As we passed along the road we saw numbers of ordinary marsh plants, but we were on the outlook for one particular flower which occurs nowhere else in the British Islands, except these western coasts of Ireland. It is one of the heaths, known as St. Dabeoc's (named after an Irish saint), and formerly christened by botanists *Dabeocia polifolia*, although now, in honour of a Scotchman, its generic name has been unmusically changed to that of *Menziesia*. By and by we came in view of this lovely plant. Great was our joy, for we had never seen it before except in the pages of Sowerby. The reader may well pardon the delight of an ardent botanist at the first sight of this plant, growing in luxuriance in its wild abodes, for its beauty is not exceeded even by the magnificent heaths which have been imported into our greenhouses from the Cape of Good Hope and Australia. Its rose-coloured, bell-like flowers are nearly three times the size of those of our English heaths ; which latter grow side by side with it, as if for the sake of comparison.

After some miles of tramping, the pedestrian will discover that he has passed the highest point of the watershed, for the streams are now flowing in a different direction. The mountain scenery becomes grander as he proceeds, the mountains presenting themselves one after another like the gigantic billows of some stormy sea. At length a glimmer of light appears between the hills where the valley ought to be, and we gradually approach Killery Bay. This is a fiord like Clew Bay, extending from the sea sinuously into this mountain-land for a distance of twelve or fifteen miles, the mountains rising in some places quite steeply from the water. Various mountain streams pour themselves into it at the head where the primitive village and capital inn of Leenane is situated. No better spot for the tourist to rest a few days could be selected than this. Along one mountain pass he can proceed to Kylemore Lough, which is, perhaps, the loveliest in Ireland, with the exception of one of the lakes of Killarney; for Kylemore Lough has not only rugged and bare mountains rising around it on every hand, but these are softened down near the margin of the lake by rounded bosses, festooned with honeysuckle, and bramble, and wild roses, the haunt of a thousand plants dear to the botanist, and now bright with three or four species of heath, including an abundance of our prized *Dabeocia.* Shrubberies of hazel bush, willows, alder, and larch come down to the very edge of the water, while above them stand stately groups of Scotch fir, whose rough stems gather all the light that is in the sky and reflect it in the very warmest of colours. Rarely have we been more pleased with a situation than that of Kylemore. At one end stands the magnificent seat of Mr. Mitchell-Henry, M.P. for Galway, who has done good work in the neighbourhood by inducing the peasantry on his estate to drain the bog lands, so that they are being rapidly converted into fertile fields.

From Leenane there are beautiful roads to Delphi, through Glen Fee, and to the Pass of Saal Ruck, a walk of about six or seven miles after having crossed Killery Bay. The bay is full of fish, especially mackerel and whiting, and this delicate food can be obtained in almost unlimited quantity. From Leenane to Cliefden is about twenty-four miles, and Kylemore Lough may be taken on the road. Towards Letterfrack we were particularly struck by the signs the landscape presents of the influence which moving ice has exerted in this region. During all our journeyings we had been beset by the strongest evidence of this kind, but nowhere is it more plainly seen than at Letterfrack. Huge hillocks of refuse are composed of fragments of rocks of almost every size of bigness and smallness, each fragment polished and scratched by the ancient ice-sheet which long ago disappeared. Low rounded bosses of rock, or *roches moutonnées*, had been seen on each side of the road all the way from Westport, many of the latter covered with groovings and *striæ*, all of them converging in the direction of the valleys. There can be little question that, before these bays or fiords were filled with salt water, they had been filled with ice, and had very probably been deepened by the mechanical erosion of the moving ice-sheets towards those deeper and lower parts now covered by the waters of the Atlantic.

Near Letterfrack we came upon some limestones which had been altered by heat until they assumed the appearance of loaf-sugar. Some of the limestones have been coloured green, and the well-known "green marbles" of Connemara are obtained from this deposit. Of them many exquisite ornaments are manufactured and sold at Cliefden, for the deposit crops out along the adjacent hill-sides. A grander country for the geologist, and especially for the physical geologist, could hardly be selected than this, for there are so many varieties of rock formations, particularly of the older and more primitive rocks, that at every few hundred yards the student comes upon a new stratum on which he feels forced to exercise his hammering abilities. Perhaps none of them struck us more than the outcrop of what had once been a Lower Silurian conglomerate, that is to say, a shingle or gravel bed, which had accumulated as such in one of the earliest geological periods. The pebbles of this bed were formed of various kinds of granite, and they had been cemented together in a sandy and clayey kind of matrix, which bore a wonderfully suggestive likeness to a Boulder-clay, until the entire stratum had become solid. Then this bed had been exposed to the influence of heat and the enormous pressure of overlying masses, so that both the pebbles and the material in which they had been imbedded had been metamorphosed together. No more instructive illustration of the great changes effected upon the configuration of the earth's surface by the agency of heat could have been afforded. The only drawback to the geologist whilst studying these rocks is the absence of a donkey-cart and a good strong donkey, for his knapsack soon gets full and his pockets weighed down; and, worst of all, he is obliged to leave specimens behind him that he would otherwise gladly carry away to gloat over and study during the winter months.

We reached Cliefden late in the evening, when the dusk was falling around us, and the neighbouring hills were gradually shading off into immaterial obscurity. We rose early next morning in order to catch the eight o'clock mail-car for Galway. Punctually to the moment, a lumbering old car, with two Irish horses harnessed thereto, made its appearance at the hotel door, an Irishman perched in front of the machine as if he were on the top of a chimney-pot. The first part of our way led us by the side of the well-known and much-talked-of Twelve Pins or Bens, both the word "Pin" and "Ben" (which is common in Scotland) meaning head or peak, in the Celtic language. The names, in this instance, have reference to a group of twelve tall mountains which stand clustered together in the wildest part of Connemara. The road to Galway winds in and out of the valleys formed by and along the base of the mountains, so that we had magnificent mountain scenery on the left-hand side, whilst, on the right, there extend, for miles, a series of lakes like "pearls on a string." Some of these lakes, as, for instance, Lough Inagh and Glenda Lough, are of considerable size, and have islands in their midst upon which are the ruins of many an old castle or keep. At Ballynahinch, in one of the largest of these islands, we behold one of the finest of these castles, that of the Martins, an Irish family which once possessed almost regal power in this part of the country, and owned no fewer than 200,000 acres of land. At Recess there is a capital hotel, much frequented by salmon and trout fishers, their prey being abundant in the lakes and rivers of the neighbourhood. Here, too, the scenery becomes more wooded ; but the drive from Recess to a village called Oughterard is one of the wildest and most dismal that it is possible to imagine. We saw it under characteristic conditions. There was a drizzling rain descending from the mountain clouds all the way, and it seemed to bring out the misery and the sloppiness and the bogginess of the low grounds in all their intensity.

As we approach Galway the country becomes more cultivated. The roadsides and walls are perfect paradises of ferns, among which *Scolopendrium vulgare*, *Asplenium trichomanes*, and *Ceterach officinarum*, are most abundant. There are signs of greater wealth, and here and there mansions make their appearance with rich woods around them. Lake Corrib stretches away to the very heart of the Twelve Pins, some forty miles away, and a steamer plies up and down the water during the summer months. At Galway Bridge we could see from the parapets the salmon in scores, three or four together, lying at the bottom of the stream, waiting for the freshets, so that they could pass up the salmon leap and through the loughs into the mountain streams above. A day or two may be agreeably spent in Galway, especially in exploring that outlying suburb called the "Claddagh," where the Spanish settlers of 300 years ago still live apart from their Irish brethren, with a mayor of their own, elected every seven years, and governed by their own unwritten laws (which are obeyed much more strictly than the written laws of the Saxon in Galway town).

We left Galway by the steamer which crosses the bay to Ballyvaughan. The day was intensely hot, and the atmosphere seemed full of light. Hence the white limestone-terraced hills of the Burren would have been unbearable for one's eye to gaze upon had it not been for the oases of greenery here and there. We think there can be little doubt that these rock-terraces are due to weathering, and that they do not represent successive sea-beaches, as some imagine. The terraces appear to coincide with the outcrop of the limestone beds, and the terraces are most pronounced towards the tops of the hills, the *débris* lying along the bases having greatly protected the lower strata from meteorological erosion. The rainfall hereabout is 54 inches in a year, and as it mostly descends in a fine drizzle, nearly every drop must tell upon the limestone, and its weathering action must therefore be almost complete.

We stayed a few days at Lisdoonvarna, a pleasant green country, richly undulated, where the Yoredale shales abut against the Carboniferous limestones, and the water percolating through the former dissolves away its iron pyrites, so as thus to form "Spas" of notable benefit. Dr. Westropp, the kind and genial physician of the place, has made a remarkable living collection of all the varieties of the Hart's-tongue ferns found growing in the fissures and joints of the Carboniferous limestone near Blackhead. These joints are very numerous, and in each of them we saw growing a wonderful luxuriance of Maiden-hair (*A. capillus-veneris*) and other ferns; while on the cliffs the surface was matted with *Dryas octopetala* (still in flower); and patches of *Statice spathulata* grew here and there, close by denser tufts of *Asplenium marinum*. Near Mohr Cliffs we found *Lastrea recurva* completely covering a bank for a short distance. These Cliffs are a magnificent spectacle, rising quite perpendicularly for nearly 600 feet out of the sea. They are formed of Lower Carboniferous rocks, the thin flagstones of which are completely covered with worm or molluscan tracks. The green Atlantic rollers, unbroken in their gathering strength by a single rock or island between here and America, thunder and surge at the bases of these cliffs, and break up into masses of foam as white as the thousands of seabirds whose cries almost bewilder the ears. We should be delighted to convey to our readers even a faint idea of the pleasure we enjoyed from the detailed exploration of the limestone "rock-gardens," surely unknown in the whole world elsewhere, of the loveliness of the green western Irish land, and of its balmy atmosphere, which one can almost taste!

The Carboniferous limestone underlies the whole country thereabout—a land bare, almost as a wooden table, of grass, and yet richly feeding numbers of sheep. The real reason why sheep are able to feed over the limestone tract of the Burren hills, is that the rocks are much fissured with the vertical cracks, in which grow the loveliest of wild plants, many of them rare to the botanist, and a profusion of such ferns as the Hart's-tongue, the Maiden-hair (*Adiantum capillus-veneris*), the Ceterach, and many others. Various species of grass also grow in these chinks, and it is upon the latter that the sheep browse, and so the spectator is presented with the peculiar appearance of sheep grazing on what appears to be a region of the poorest and the baldest rock.

CHAPTER VII.

A NATURALIST ON THE TRAMP (No. II.)

IN spite of the "good old times" of which we often hear so much, we have an advantage over our forefathers in the facility with which we can annually throw off the year's burden of cares, and run away for a week or two's change. How temptingly the tourist advertisements read to a man who is on the look-out as to where he shall go, and who is perhaps realising more pleasure in the anticipation of his summer outing than he will experience when actually enjoying it! And how tantalising they must appear to an individual, equally willing and more ardently wishing to go, but to whom ten pounds is of greater importance! But still, there are few of us in active employment, not excepting working-men (or the "wage-class," as they are sometimes termed by political economists), who cannot, in the course of the twelve months, lay sufficiently by to indulge the body and mind in a day or two's excursion to some spot, famous for its scenic or other attractions. In the manufacturing districts we have frequently noticed with pleasure how common it is for working-men to take their wives to the Isle of Man, Southport, Blackpool, or some other watering-place, for a week's holiday,—the expenses of said excursion being defrayed out of the collection of odd sixpences which the husband (herein true to his *name*) has been forming during the year, instead of allowing *them* to beguile *him* to the gin-palace! If every working-man and woman in this country could be thus pleasantly knocked about once a year, it would sweep a good many social and perhaps moral cobwebs away,—and would do more to remove old prejudices and superstitions, and to expand and elevate peoples' minds, than years of staying at home would induce.

Among the many pleasant reminiscences of summer rambles (now extending over many years, and which have been enjoyed in almost every part of Great Britain) few stand out more prominently than our first fortnight's ramble about Llangollen in North Wales. No other locality in the Principality is so abundantly rich in material for the geologist and botanist, for within a radius of a few miles there are some of the best fossil-hunting grounds we know of, in the Carboniferous limestone and Silurian formations. It is not the mere change of air and scene that is beneficial to one in these outings,—there is to be considered also the rich store of knowledge which may be gleaned. Many a time, in our dreams, or suggested during a casual conversation, or by some reference to a book we may be reading, we can go back to the scenes of former rambles, and enjoy them over again! The mind is strengthened, and one's moral nature purified, by reminiscences of this kind. That grand view of the mountains for the first time, the stretch of lake scenery, the solemn sunset among the hills, when the night-wind began to whistle, and we were tramping, footsore and weary, to our night's quarters,—all these incidents can be restored in a moment! We can recall the maritime landscape of some beloved and never-to-be-forgotten spot, now unvisited for years,—the kind friends we met for the first and last time as we ascended some steep mountain-side,—the delicious summer moonlight scenes far away on the Scottish lochs or the Cumberland lakes. All the hard work and bitter care of our lives cannot rub out these pleasant reminiscences; and memory does well to guard them like so many blessed recollections.

As you walk along some of the silent mountain roads in North Wales, with the mountain wind blowing in your face and inflating your lungs, you cannot help feeling how nearly allied good health of body is to peace of mind. You step lightly and firmly out, and some catch of a song you have not heard—much less sung—for years, bubbles up in your memory, and unconsciously expresses itself in sound. You seem to yourself to have gone back in your life ten years by the change! Below you, some hundreds of feet, the mountain rivulet is brawling and foaming, silently reducing the hard, angular masses of slate rock, which nearly block up its bed, to their original fine mud and sand. Did you ever, in sheer idleness, or possessed by the "spirit in the woods," of which Wordsworth spake, sit by the bank of such a stream, and let your thoughts or reveries play freely at will? If so, you will remember experiencing some of the most soothing and seductive moments of relaxation you ever enjoyed. What thoughts the very play of the water seems to call up! It looks quite black in the deeper pools, where the current swells and eddies and pauses for a moment, as though it had got rest at last, and was free from the seething rapidity with which it had been dashed down the mountain ravine. The overhanging pines and alder bushes make these deep pools appear all the more gloomy. Just before you, the stream comes rippling over its uneven bed with some attempt at regularity; and as you recline, you catch the light and shade of the surface-ripples. For what untold ages has that shimmer of light gone on!—how many more generations will it see die out and be forgotton ere the river's course be changed! There is something at every turn in the world which makes a thoughtful man feel how temporary is his tenancy of it! And yet what objects of beauty greet one's eyes whenever we give them a chance to observe. It is surprising, too, how little incidents like those we have been describing will recur to memory in years hence, long after what we deemed greater and more important matters have been totally forgotton. That group of foxgloves growing on the margin of the river—how pretty they look, nodding to and fro, as if, Narcissus-like, they were admiring their own beauty in the water which so distinctly reflects them. We feel certain, as we look, that we shall see that little picture for years to come. Perhaps it will suddenly present itself when some great sorrow is upon us, and the soul is dulled by the weight it has to bear; and then, like an angel of mercy, the image of the foxgloves comes up, and the mind dwells on it with unconscious reverence and pleasure! Truly, all these organic objects are "ministering spirits sent forth to minister."

Let us back to the ascending mountain road again. Above and beyond, the hill-tops rise out of the "sea of pines" which clothe their bases. What a purple light there is reflected from the rugged slate rocks! One never sees it in good pictures without thinking the artist has been taking a little liberty. The mottled green of the short turf causes the hill-tops to look even more attractive. The streak of brighter green here and there shows us where some little rill is trickling down the slope. Lower down the purple heather lights up the uneven flanks with a vivid and yet mellow colour.

Whilst you were silently drinking in the impressive beauty of the scene, you had noticed that the silence was broken by a sudden boom, then a crash, followed by a prolonged roar; and had wondered what it could mean. It recurs again and again, and meantime your senses are keenly on the look-out for the cause. At length you discover it. On the hill-top, or nearly so, across the valley, your eye catches the reflection of a moving mass, which you soon afterwards discover to be slate refuse, just thrown down from a small slate quarry: the sudden boom you heard was a "blast," the crash was caused by the falling mass of rock which had been liberated by it, and the roar was due to the occasional emptying of a wagon-load of refuse down the great heap that has accumulated just outside the quarry. Every time such a load is emptied it seems as if it set the outside of the heap in a general commotion. Perhaps you have never explored a slate quarry, so we invite you to accompany us first to one of the few smaller ones which are opened in the Wenlock Shales near Llangollen.

Few things are more difficult to judge upon than where a really good and profitable bed of slate rock occurs. Generally these beds (or "veins," as the workmen call them) are very limited, and occur in the midst of a considerable mass of schistose rock, or other slates too much broken or too badly "cleaved" to be of much commercial value. Besides, unless the slate quarry is situated near some good road, railway, or seaport, and there are means of getting rid of the vast accumulations of rubbish that always result from slate working, the quarry cannot be wrought with any great advantage or profit. But surrounded by these advantages, a slate quarry is then more profitable than a gold mine! These workable slate beds are not peculiar to any one geological formation, although, in North Wales, slates are chiefly obtained from that great deposit known as the *Cambrian*. In the neighbourhood of Llangollen, however, they are worked in a more recent formation —one known as the "Wenlock Shales," a member of the *Upper Silurian* rocks. These strata are in all cases of clayey origin, and were originally accumulated on ancient sea-floors as thick deposits of fine marine mud. Some of the large slabs of slate obtained in the Wenlock Shales of Llangollen bear the most beautiful impressions of groves of ancient *Encrinites* or sea-lilies—stems, heads, arms, fingers, etc.,—just as they formerly lived on the sea-bed! Besides these, you may obtain innumerable casts of extinct shells,—far too numerous for the quarrymen's liking—such as *Orthoceras primeva* and *Cardiola interrupta.* As far as their *mineralogical* composition goes, however, the slate beds both of the Cambrian and Upper Silurian formations are nearly identical. The best and finest slates in Wales are usually obtained from the Cambrian rocks. The fine clayey or *argillaceous strata* of these primary formations always present a very peculiar appearance. Their original sedimentary structure is usually quite lost, owing to the heat and mechanical pressure to which they have been subjected during the thousands of physical changes, upheavals, and depressions, which have taken place in the earth's crust since they were formed. Hence it is that the external marks of the mechanical origin of such rocks are nearly always obliterated, or but faintly visible. Rarely indeed do we find them splitting up along the plane of deposit; that is, into the thin layers which represent the accumulation of the ancient sedimentary matter. In the place of such "bedding,"—that is, of the layer on layer usually seen in shales and other rocks, and which is due to the gradual accumulation of the material by which such rocks grew to their present thickness,—these ancient slate beds have assumed a peculiar structure, due to the mechanical, chemical, and physical changes above alluded to, technically called *cleavage.* It is this change which makes the slate rocks so commercially valuable; for, owing to it, the slaty masses will split or *cleave* into the thinnest of plates or layers along this plane of *cleavage;* and thus they can be readily prepared for roofing and other purposes. In the winter-time great masses, which have been quarried on purpose, are often allowed to stand in the open air so that the frost can operate upon them; the result being that the slates are neatly cleft, and only require clipping to their available shapes.

In quarrying the masses of slate rock, the quarrymen have to bear this "line of cleavage" in mind; and they usually so bore the holes in the rock, which are to contain the charges of powder for blasting, that huge masses are detached, each having more or less of a cubical shape, owing to the natural joints which intersect the rock. In the smaller quarries, such as that we are now exploring, it makes one's flesh creep to watch the men at work. They are gibbering to each other in Welsh, and talking as fast as only genuine-blooded Celts can talk! The bare, wet face of the rock is nearly vertical, and its base terminates in the deep quarry, a hundred feet below. Here and there strong ropes hang loosely down from the top; and you see the men catch hold of these, and steady themselves along the rock-face by their means, whilst they follow their work. A score or two of men are busily engaged in boring holes in the rock, each hanging in this perilous manner. Suddenly a loud and shrill whistle is heard. This is a signal that the blasts are about to take place, and that the slow fuse is being fired. Instantly, and as if by magic, the quarrymen run along the rock as if they were spiders,—catching hold of one rope after another, like the monkeys in the Zoological Gardens, —each man hiding in some prepared nook or cranny. We are hastily hurried away by the overseer, and not even allowed to peep round the corner; for the fragments of hard slate, when blasted, will fly off in every direction, like so much canister-shot. We wait in the tunnel in breathless silence and expectation; and the few seconds which elapse before the shot is fired seem quite an age. At length it comes, turning us momentarily deaf, so that we hardly hear the crashing fall of the dissevered rock-masses, or the rolling echoes which follow each other along the mountain-side. Perhaps two or three blasts succeed each other; for these are generally arranged to come off together, in order to save time. When they are over, you see the men swarming forth out of their hiding-places like so many bees, and toiling away again as if nothing had happened! In spite of all the precautions which are taken, and they are both numerous and effective, some shocking accidents often occur in these slate quarries, but generally through the carelessness or rashness of the men themselves.

The quarrymen engaged in such workings as these have usually to come a great distance; hence you see no houses about, except a few sheds erected perhaps by the single men, who prefer to live in them from Monday to Saturday to going home great distances. Although their dangerous calling is apt to induce the callousness peculiar to men like colliers and sailors, who pass the greater part of their lives in great peril, the slate quarrymen are, as a rule, a very religious body. Calvinistic Methodism is the denomination they usually affect; and you see their neat and unattractive chapels in every village you pass through, with its name inscribed perhaps in English and Welsh. Round about it the "rude forefathers of the hamlet sleep;" and at the heads of the graves stands a slate slab, recording in Welsh the virtues of the deceased. The village schools are generally attached to these chapels; and perhaps you are passing one such when the youngsters are issuing forth to play. Sidney Smith said, when he was in France he was most struck with the ease with which the children spoke French! The same thing strikes you of these Welsh infants; for they are gesticulating, and pouring forth torrents of unintelligible jargon, not one word of which can you understand.

In the large quarries, such as those at Festiniog, Llanberis, and Bangor, a different style of working is carried on from that above described. Here so many men are employed that it requires no small degree of engineering skill to so direct their operations as to make them most effective. The slate rock, when the strata are thick enough, is usually worked in huge terraces, each terrace being about fifty feet above the other, so that frequently the upper terrace will be five hundred feet above the lower. Flights of steps communicate with all these, from the bottom to the top. On each terrace there are laid iron rails for the wagons to run upon. These are of two kinds: one for carrying away the slates, and the other the refuse. The latter are capable of being tilted, so as to enable them readily to discharge their cargo. As you stand below such a slate quarry, say as that at Llanberis, you cannot but admire the scene. Before you is the picturesque lake, five or six hundred feet deep, which our best geologists state had its rock-basin deepened, if not actually hollowed out, by glacier action during the period of the Northern Drift, and when these mountains were covered with ice and snow like the flanks of the Alps. On the other side the lake is a huge hillock of slate refuse, as big as many a hill we have seen elsewhere dignified with a Celtic name. Unfortunately this heap is slowly encroaching on the lake; and though it will take a long time to fill the latter up, it is undoubtedly interfering with its beauty. On the terraces the workmen swarm like ants; for there are about two thousand of them altogether, men and boys. From the point where you stand, near the old Welsh castle of Dolbadarn, a little geological knowledge will indicate to you how violently this part of the country suffered from volcanic action during the Cambrian epoch, although these huge mountains and deep valleys are not due to upheaval, as we shall presently show. The volcanic forces just mentioned were in operation when these slate rocks were forming, as so much fine mud, along the bottom of the ancient Cambrian Sea. Then ensued volcanic outbursts from submarine vents, and then it was that these layers of igneous rock and ashes were ejected, to roll and spread over the sea-floor.

At Festiniog there are several extensive slate quarries, the principal of which is that known as the "Palmerston" quarry. As a rule, the larger of these various quarries are worked into the solid rock in a horse-shoe form, all the terraces being thus worked together. The numbers of new houses, and the apparent air of prosperity everywhere seen at Festiniog, at once indicate to the visitor the number of people here employed. They are, of course, chiefly Welsh; and one incident struck us very much whilst staying at an hotel here. The evening was terribly wet, too wet to go out; and the time hung heavily on our hands. A large company had gathered in the smoke-room, principally of the slate quarrymen; and these were being entertained by performances on the Welsh harp. One man, whose mobile face vividly showed the slightest feeling that crossed his mind, was singing in Welsh,—or rather, was chanting or intoning some lengthy lay. The whole company looked on with much interest, and presently this increased to real excitement, so that every now and then the vocalist was interrupted by their repeated cries of applause or indignation. The singer himself grew intensely excited, his eyes were starting, his mouth almost foamed: and as if the strong expressions of his face were not able to help him to deliver himself of his ideas, his hands violently gesticulated, and his whole body quivered with emotion from head to foot. We never saw a sight like it before; it was as if one of the ancient bards had risen from the dead to go through his performances in a modern hotel! We observed that his voice rose and fell in cadences; and that at regular poetical intervals, *alliteration* was employed instead of rhyme. On inquiry as to the subject-matter of the entertainment, we found it was *extemporaneous;* that the singer had been including all the events of the town and the proceedings at the slate quarry; and that his recitative had been composed as he proceeded. It was one of the most marvellous "restorations" of the ancient bards—of the first birth of poetry, when poetical feet was all that was required—that ever we listened to; and it was all the more interesting because the vocalist was an ignorant man, unable to speak English, who had unconsciously resting on his shoulders the garment of the ancient British bards!

The slate quarries at Penrhyn, near Bangor, have already been described. The guide-books are not wrong in including them among the "sights" of

North Wales. More than two thousand people are employed in them, and have been for many years, for these are the oldest slate quarries in Wales. It is in consequence of the long time they have been worked that their appearance is so very impressive: huge precipices, disused terraces, hills of loose refuse, —all these surroundings speak volumes of the human labour which has been here expended. "Piece-work" is the system of labour usually employed in the largest quarries; that is, the principle of paying the men so much for the work done. Good wages are therefore earned by all employed; and the industry displayed, and the intensely busy appearance of the workmen in such quarries, are quite striking. They have no time to look at a visitor, no time to make remarks to each other, for these would be at their own expense! The principle of division of labour is very perfectly carried on, from the blasting and bringing down of the rock-masses, to their subsequent splitting up and finishing off into "queens," "duchesses," and "countesses," etc., such being the high and mighty titles under which the different sizes of finished slates are known to the trade.

At Festiniog the celebrated Port Madoc diminutive railway runs right up to the quarries, and carries away thence the wrought material, for shipping to every part of the world. And a comical sight this railway appears, to our cockney eyes, with rail-tracks two feet six inches wide, and carriages on whose roof you could sit and almost dangle your legs over each side! This line, nevertheless, is said to pay the best of any in the kingdom. It crosses the ridge of high hills, its small but pretty locomotives looking like the young of the huge monsters we see on the usual English railways. Here and there you note a narrow line running down the steepest part of the mountain-side. This is for the purpose of letting the laden slate wagons down on the regular railway, which is done by means of a stationary engine. A train of such wagons rushes down the steep incline as if an accident had occurred; but it stops at the bottom as quietly as a butterfly alighting.

No better idea of Welsh scenery, of its geology and physical geography, can be seen than lies on the road from Bedgellert to Llanberis, by the way across Snowdon. Indeed the scenery along this route is among the very finest. Grand, cloud-topped mountains rise bluely on every side, their riven sides gaunt with the rocky ribs which stick out. In the valley where the village of Bedgellert stands, the bright river sparkles as it dashes rapidly over the stones; and the rich meadows are covered here and there with bosky woods, whose soft picturesqueness causes the neighbouring mountain scenery to look more grandly rugged than ever. After passing by the fine old bridge, you take the road leading to Capel Curig, which you follow a short distance before you turn off to begin the ascent of the Snowdonian range. We will not stop to describe it,—everybody has done that, more or less, who has been in North Wales; and each has imagined that nobody had such a climb as himself. But only one pen has done justice to the noble majesty of Snowdonian scenery—that of Charles Kingsley, in his *Two Years Ago.* The genial Canon was an ardent lover of Welsh scenery, and he always wrote about it like a man who had felt its awe-inspiring power.

We toil up one acclivity after another in the vain hope it is the last peak, instead of which it is only to show us one higher still. The tediousness of the slow climb is beguiled by the objects we presently come across,—Arctic plants, such as *Saxifraga stellaris*, *Rhodiola*, etc., isolated from their natural home, and growing on these mountain-sides to tell of the physical changes which have taken place in Great Britain since the Glacial period. Here and there, in the damper clefts of the rocks, grows the pretty little parsley fern. The rocks themselves are, in many places, full of fossils, or rather of the natural *casts* and impressions of fossils,—remains of some of the oldest organisms that peopled the earliest seas of the globe. The mountain mists now begin to gather thickly, and we are climbing amid what is really a dense cloud. But the wind is tolerably high, and every now and then it tears part of it away as if it were tissue-paper, and gives us a glimpse of the distant landscape. What a scene! Mountain rises behind mountain in billowy wildness, and dark tarns lie at their bases or fill up the yet deeper slopes of the valleys. There they reflect the subdued light, and the mountain-peaks see themselves ruggedly mirrored. How difficult it is to realise the fact, that the *material* of which this grand scenery is composed was once deposited as marine mud along the bottoms of primæval seas,—that the very impressions of shells we see in the rocks are the eloquent, though silent, remains of the ancient creatures which lived in those primitive oceans! This Welsh scenery is among the *oldest* in the world,—older, by whole geological periods, than the Alps, Pyrenees, Himalayas, or Andes. Its character is due, *not to upheaval*, as so many people hastily assume without having examined the district a day, but to the alternate occurrence of harder and softer beds of rocks. In the long ages during which these rocks have been exposed to atmospherical wear-and-tear, the softer parts have been eaten out; hence the Welsh valleys always occur where the softer rock crops out. The mountain scenery of the Snowdonian district has been carved by the hand of time, with no other tools than the same agencies of the weather we still see going on around us. The last touch of the tool that produced the most decided scenic effect, was during the geological period immediately antecedent to the present, and which is known as the "Glacial epoch." An Arctic winter then reigned over what is now

Great Britain,—for how many thousands of years we dare not say; and then it was that these mountains and valleys were wrapped in ice and snow. You cannot stir in this district, if you have a geological eye, without seeing as ample traces of ancient moraines, "muttoned" (or rounded) rocks, ice-scratchings, etc., as if you were observing the existing glacial phenomena of Switzerland. Most of the Welsh lakes owe their origin entirely to these ancient glaciers, which here scooped out the solid rock by their mechanical movement, often to an immense depth; or else banked up a valley with morainic matter. In most of these lakes, also, there may be found, still living, fresh-water fishes only to be met with in similar glacial lakes in Scotland, Switzerland, Norway, and elsewhere.

At length we reach the wondrous summit, and commence the descent to Pen-y-Ghent. The comfortable inn at the latter place is reached in the evening, and the cheerful and welcome fire enables us and other mountaineers to dry our clothes, previous to walking down the Pass of Llanberis. Truly, a wonderful place this pass,—looking as if the rocks had been rent in a zigzag fashion. And yet we know that it is only a natural fissure, *not* formed by volcanic agency, as one is apt to imagine on first beholding it, but due probably to a simple crack first caused by the consolidation of the strata, and then worn wider and wider by ordinary atmospherical and lastly glacial action. You may still find, high up each side, horizontal groovings which at once tell of the ancient glaciers that formerly filled this pass, and also record the thickness of the moving ice-sheet. There is nothing that awes one more than to have slowly forced on the mind the fact that these and similar phenomena, which it seems impossible to have been produced otherwise than by such sudden and violent means as a powerful earthquake or a volcanic eruption, are only the result of slow and imperceptible meteorological action, extended over perhaps millions of years! The moral of the Old Testament narrative is practically realised in such phenomena as these,—the power of the Almighty is not always most seen in the violently sudden (as it is the tendency of our weak minds to imagine), but in the long-continued and imperceptible. The power lies not in the earthquake, nor in the whirlwind; but in the "still, small voice" of Nature!

CHAPTER VIII.

A NATURALIST ON THE TRAMP (No. III.)

THE dwellers in the agricultural parts of "merrie England" cannot imagine any scenic contrast more startling than the difference between their part of Britain and that generally known as the "Black Country." Never did an area better deserve a name! Geographically it includes the tract lying more or less between Wolverhampton and Birmingham, the centre of the district being at Dudley. And yet it is not difficult to imagine that at some distant period of the past, this must have been a very picturesque region. Even now, the limestone ridge at Dudley, known as the "Wren's Nest," rises up in a very imposing manner, although the plains stretching away in a south-easterly direction are so very unlovely. Dudley Castle looks down from its woody heights on a night scene more strange and weird than any that could be selected elsewhere in England. And yet this is classic ground to the young geologist; for these limestone rocks are crowded with upper Silurian fossils so thickly that you cannot place your finger's tip on the surface of a slab without covering or touching some ancient form of life! The rocks rise at a steep angle, and are so hard that very little vegetation can gain a foothold. At their base lie the Coal measures, wrapping round the hilly ridge, and containing that wonderful seam of coal, thirty feet in thickness, which has transformed this region into one of the busiest in Great Britain. The fossils standing out in bold and beautiful relief on the limestone slabs of the "Wren's Nest" tell plainly of ancient marine conditions, when coral-reefs studded ancient seas, and forgotton types of marine life did similar work to that now performed by modern organisms. What a contrast between those ancient and silent conditions, long ere man was created, and the present, when he is stamping his presence so distinctly on everything around him!

Just about the period when oral passes into written history, we obtain occasional glimpses of a very different state of things in this district from those we now meet with. We have knowledge of ancient forests, older than the days of the Silures and

Brigantes, clothing the wide area of the "Black Country," in which roamed wolves, wild boars, and bears, that were hunted by aboriginal tribes hardly less savage. Subsequently these ancient forests were cut down and burnt for charcoal, in the days when coal was unknown. The region was rich in iron ore, and the charcoal was used for smelting it. This roundabout process took place notwithstanding that the thickest coal-seam in England—that technically known among miners as the "ten-yard coal"—actually cropped up to the daylight, in the very centre of the region where the ancient forest grew.

A visitor, fresh from and fond of the country, longs, like the hart for the water-brooks, to get away from the naked, treeless "Black Country" to shady lanes and purling brooks. But it is a country where "a good deal of money is made;" and there are some who believe that if such news went forth of a country blacker still, there would be a migration thither before long! Every step one takes in the "Black Country" almost painfully impresses us with a sense of the enormous wealth, in the shape of invested capital, there represented. Nowhere else have we seen human life and labour so apparently subordinated to money-getting. It would almost appear as if this were the great end of life, and that human existence was formed solely with a reference to it! In this locality, in the day time, when the summer sky would be clearest and bluest elsewhere, a curtain of black smoke, often very dense, is drawn across the sky. From this curtain there are constantly being rained down minute "blacks," which get into one's eyes and irritate them most unpleasantly. The "Black Country" is very flat away from the hilly region, and it appears crowded with forests of tall and tapering black chimneys, and with equally black iron furnaces, whose shapes remind you of huge opera-glasses. Lines of railway run in every direction, and so intersect each other that from a balloon the land must look as if matted with an enormous spider's web. Canals, of a date anterior to that of railways, and which were the first expressions of a felt want of locomotion, wind to and fro, the water in them being of the consistency of burnt pea-soup. The grunting of stationary engines, the puffs and shrieks of locomotives, the clanking of iron pulleys and chains at the coal-mines on every hand, fill the atmosphere with a loud and most unmusical chorus. In spite of the vast wealth and enterprise manifest in the "Black Country," a few of the coal-mines bear a very antiquated appearance. Their machinery is of the oldest, and you see the ropes being slowly wound up, perhaps by horses, on a huge horizontal wooden pulley or drum. Of course there are many collieries in which the coal is worked with the most elaborate machinery, and on the best scientific principles. Some of the smaller pits, perhaps, are owned by working men, and are wrought on the co-operative principle. Hence both time and labour are often much wasted for want of capital to supply more elaborate machinery.

All under the "Black Country," or nearly so, the "ten-yard coal" extends, or rather *formerly* did. As its name implies, this vast seam is thirty feet in thickness. Here and there thin seams of shale, or bad coal, run irregularly through the mass; but the whole is usually worked together. The estimated workable area in the neighbourhood of Dudley is 65,000 acres; but there can be little doubt this computation is far below the mark. This coal-field generally goes by the name of the "South Staffordshire." Besides the "ten-yard coal," there are no fewer than ten other seams of the same precious mineral underlying the one we have been describing. These seams lie very near together, so that the deepest shaft rarely exceeds 800 feet,—not much more than a third of the depth to which some of the Lancashire coal mines go down. Among the most valuable of the different varieties of coal obtained near Dudley, that called *cannel* (derived from the word "candle," on account of splints being used for lighting) is the most esteemed. What a vast mass of ancient vegetation is represented by these coal-seams! For, when uncompressed, the ancient vegetation must have represented a thickness of deposit compared with which the "ten-yard coal" is very small. And yet everywhere we have evidences of slow deposition,—of similar physical conditions existing to those which the geographer can still point to. Poor Hugh Miller, speaking of this same "Black Country" coal-field, says, "In a colliery near Wolverhampton the bottom coal rises to view; and where the surface has been cleared of its alluvial covering, it presents the appearance of a moor on which a full-grown firwood had been cut down a few months before, and only left the stumps behind. Stump rises behind stump to the number of seventy-three in all; the thickly-clinging roots strike out on every side into what seems to have been a vegetable mould, but now exists as an indurated shale. Many trunks, sorely flattened, lie recumbent on the coal; several are full thirty feet in length, while some of the larger stumps measure rather more than two feet in diameter. There lie thick around *Sigillaria*, *Lepidodendra*, *Calamites*, and fragments of *Ulodendra;* and yet with all the assistance which these lent, the seam of coal formed by this ancient forest does not exceed five inches in thickness! Not a few of the stumps in this area are evidently water-worn. The prostrate forest has been submerged, and molluscs lived, and fishes swam over it. This upper forest is underlaid by a second, and even by a third; we find these full-grown forests, closely packed in a depth of not more than twelve feet!"

The great thickness of the "ten-yard coal" necessitates quite a different kind of coal-mining from what is usually known elsewhere. Indeed, we may roughly divide our English colliers into two great classes,—those who have been accustomed to work thick coal-seams, and those used to thin ones. As quite different methods of working are required for these extremes, it is often a difficult thing indeed to get a collier who has been brought up to thick coal-seam working, to mine in a thin one, and *vice versâ*. Not unfrequently, also, the two classes of colliers entertain a foolish prejudice against each other,—a prejudice which is perhaps as well grounded as many others!

In the "Black Country" area (including Wolverhampton) the "ten-yard coal" has been worked for many years, and as a necessary result, the overlying rocks have gradually settled down over the excavated area. This is always the case with coal-working, no matter how thin the bed may be. Even when working the coal, the ground "creeps," that is, the upper rocks slowly belly down, while the nether rocks as slowly crumple up. In working coal, especially in thick seams, huge pillars of the valuable mineral are left at short distances to support the roof; and so great is the pressure on these, that between them you may see the roofs bellying down, whilst the rising of the "floor" is due to the pressure exerted on it by the pillars. By and by the roof and floor will meet, and the hollow left by the worked-out coal, however vast, will be filled up. It is usual, when all the available coal has been worked out of a thick seam, to finish up by removing the coaly pillars left to support the roof. This, as will be easily imagined, is a work of no small danger. Beginning at the most distant end of the mine, the pillars of coal are removed, and old timber is made to replace them. The cracking and creaking noises made at such time are something awful, and would terrify a person out of his wits who had not been accustomed to dangerous work of this kind.

In consequence of the ground sinking in the manner above described over the excavated coal-seams, the upper surface is very much affected. The level of the water in the canals which intersect the country is constantly being altered, and the banks have to be continually built up to hold in the fluid which goes by that name. So frequently have these banks been raised, that in some places the water is fifteen or twenty feet in depth. But the most apparent effect of the settling of the ground over the emptied coal-seams is to be seen in the houses and chimneys of this densely populated district. On seeing them for the first time, you are almost inclined to believe that an earthquake has been doing its best to shake the whole lot down. Tall chimneys lean threateningly on one side, or are curved in a most comical dog-legged fashion. Single cottages, especially if they are old, that is, if they have been built twenty or thirty years, are shored up with stout timbers, either in front or at their gable ends. There is no particular order in this leaning, which adds considerably to the confusion. Some houses seem to be making up their minds to come down front-ways, others are slowly falling on their rear-ends, whilst not a few are going sideways, like so many drunken crabs. Huge cracks traverse the walls from roof to floor, and then pass into the ground beneath. Not unfrequently during the night a row of cottages will settle down so that all the doors are wedged fast, and the only possible exit is by the windows! Meantime, the public roads are black with coal-dust, and the constant traffic renders it impossible to keep them long in decent repair. A most ludicrous sight it is to see the linen on a washing-day, hung out as if it were set as traps to catch the largest possible number of the "blacks" which are settling down so fast!

But to see the "Black Country" with the greatest effect, you should pass through it at night, when "trade" is extra good. It is then a fit subject for the pencil of Gustave Doré,—looking like some scene from Pandemonium! The opera-glass-like furnaces are belching out long angular flames from their summits, and hundreds of them may be seen blazing away at the same time, so that the red glare of the sky is seen by the railway traveller for miles before he reaches the scene where the iron-smelting is actually taking place. The bases of these furnaces are constructed to allow the molten metal to be drawn off, and in front of the lurid light which streams forth, the busy, perspiring workers, look like the fabled gnomes of Arabian story. It is quite a Rembrandtesque scene,—with vivid lights and shades, such as no artist durst attempt in a picture, for fear of being esteemed unpractical and unreal. As the railway train dashes you along, you cannot help putting your head half out of the carriage window to gaze on the weird scene stretching away to the farthest horizon. Flames are shooting up, in couples, from a hundred furnaces at least; and again as suddenly settle down to darkness. The roar of the flames combines in a not unmusical chorus, in which shrill whistles of the busy engines mix at times with a peculiar effect. The white, green, and red lamps of the numerous signal posts belonging to the various branches of railway which so frequently intersect each other, look almost like the streets of a strange and un-English town.

It is a famous country for "King Iron,"—no other tract is so favourably situated for reducing iron-ore. The coal is at hand, in the very thickest of seams, the limestone is abundant with which to flux the rough ore, and the district is so thickly populated that there is no lack of labour. In the day-time you see that every furnace has in its neighbourhood a huge hillock of slag, cast in shapes, like the loaves baked in tins to be seen in our bakers' shops. Along the highways, as you walk or drive, there lie heaps of these slag-castings, ready to be broken up for the purpose of mending the roads. And capital road-metal they make, as any one can testify who has travelled in these parts, notwithstanding the immense wear-and-tear to which the roads are necessarily subjected. This slag is a silicate, and therefore resembles melted glass.

The part of the "Black Country" where iron-working is most actively carried on is at Bilston. Here there are no fewer than seven seams of Ironstone, all of which go by technical names given to them by the miners. Many of them are not more than five or six inches in thickness, and are of the kind known as clay or *Argillaceous* ironstone. Two of the seams or bands are thicker and more valuable than the rest. All these workable bands lie beneath the "ten-yard coal." The usual method, for economy's sake, whenever practicable, is to work two or more seams together. Material is left to support the roof, much in the same manner as has been already described in coal-mining. The pits where the iron is worked have often a crazy and antiquated look; and the men about the surface, with their blue eyes and flaxen hair, tell you plainly of uninterrupted Saxon descent. They gaze on a stranger with a peculiar stolidity, and express their opinions of him to one another audibly, as if he were deaf or absent. Sometimes these opinions are far from flattering, for the most peculiar points, to them, are those first seized upon for criticism.

After you have inspected the nodules of ironstone brought up from below, and perhaps broken one or two open, to find inside the frond of a fossil fern, beautifully preserved, which ages ago served as a nucleus around which the ochreous matter gathered, you express a wish to survey the interior of an iron-mine. There will not be much difficulty experienced in obtaining permission, for the adage is true here, *facile descensus, etc.* You get into a squarish wagon, and balance yourself against one of the workmen, clinging to the iron chain, and with one leg hanging loose in the deep shaft down which you will have to descend. As you are slowly lowered, the ram-shackly old cage swings to and fro like a pendulum, and you use one hand to prevent yourself being too rudely dashed against the side of the pit. At length the bottom is reached, and you are set free from this danger, and at liberty to indulge your curiosity. The general engineering arrangement recalls vividly that of an ordinary coal-mine. Here, however, there is no danger from noxious gases, and you are not oppressed by the dry sultry heat which so distressed you in the coal-mine. Consequently you take little heed of the fact that the place is a good deal wetter and dirtier, for you are protected against these by the flannel trousers you pulled over your own, and the long jacket you drew over your coat, in the little hut above-ground. You gradually make your way to where the men are at work, each one lying on his side, and deftly striking in front of him with his pick, removing the ironstone nodules and the clay in which they are imbedded at the same time. But if the iron-mines are safer from dangerous gases than collieries, they make up for this in the dangerous "roofs" left, which not unfrequently come down in great masses, and bury the poor workers alive, and perhaps beyond the hope of recovery. If you know this, you naturally regard every bellying down of the roof you pass or creep under, with great suspicion, whilst every sound louder and more unaccountable than usual, you listen to, fearing lest some part has fallen and cut away your connection with the mouth of the shaft, and therefore from the living world.

One cannot but deplore the too numerous miserable surroundings of the "Black Country" colliers and iron-workers. True, they are rapidly improving, but they are still far from what they should be in a country avowedly the most Christian in the world! These surroundings cannot fail to have a deleterious effect on their moral and social character. When houses so soon get dirty, the women become disheartened, and by and by give up all attempts to keep them clean. And the creaky, unstable ground soon makes the outsides of the houses look quite as bad as the insides. Meantime, the grimy, smoky atmosphere kills off all the shrubs and trees, and so renders gardening impossible. Hence there is no healthy recreation at hand for the leisure hours which have been multiplying since the short-time movement set in. Dirty homes soon get supplemented by uncleanly wives and disorderly children, and, too often, brutal brawling takes the place where home affections ought to flourish! In fact, "home," under such circumstances, becomes merely a place to sleep in, and hence it is that the public- and beer-houses get peopled so thickly. The vast numbers, and frequently tawdry ornamentation of these houses in the "Black Country," affect one painfully, and we cannot but feel that an action and reaction of this kind must keep these hard-working and otherwise honest people in a state of vicious ignorance. For want of a natural and healthy recreation, both colliers and iron-workers keep numbers of dogs, generally for fighting or running purposes,—both of them barbarous engagements. But the dangerous work and strong natures of the people hereabouts cause them to like everything equally strong. The "Black Country," therefore, is the home where the best bull-terriers and prize-fighters (human) are bred and reared and trained; and where religious inclinations turn towards the "Ranter," or Primitive Methodist form. To hear a "Revival" service in one of these Methodist chapels would somewhat startle the æsthetic decorum of Ritualists, but there cannot be a doubt as to the sincerity displayed. Nor can the power of a religion be gainsaid, which can thus transform rude men into genuine, if noisy, Christians, and convert them into good members of society. And the tales of self-devotion of many of these altered men, under circumstances of suffering and death such as are only to be met with in this district, are too numerous for even reference to be made to them. The best test of the sincerity of the "converts" is that their old, and still brutalised companions will respect it; and, not unfrequently, will be led by their altered lives to adopt that which has wrought so great a change.

CHAPTER IX.

A NATURALIST ON THE TRAMP (No. IV.)

NEVER had our toilers underground received such attention as that paid to them and their doings just before the outbreak of the Russo-Turkish war. England suddenly roused herself to inquire further about the people at whose mercy, on whose indolence or industry, she is told she so largely depends. Our first-class journals sent out "Special Commissioners" to report on their habits, their manners and customs, as if they were inhabitants of Borrioboolah Gha! Our illustrated papers commissioned their best artists to sketch the British collier and his surroundings. It is evident from all this that, as regards the collier, one half the world doesn't know how the other half lives. But even the hardihood of journalists seems to have stopped short at going down the coal mines, and seeing the colliers actually at work. Perhaps they felt like the Oldham weaver, who remarked that "he didn't care how high he went up, or how low he went down, so that he had one foot on the ground!" We purpose, therefore, by deputy, to take the reader to a scene of "real life" more than a third of a mile below the surface.

Strangers coming from fresh and breezy country places are not long before they notice an atmospherical difference in the smoky air of the "coal districts." Within seven miles of Manchester is situated the colliery to whose underground workings we are about to descend. It is known as one of the deepest coal-pits in England; and the machinery for working it, and the general engineering management, as being among the most finished and perfect. We could not select a place, outside the "Black Country" proper, where human industry is more painfully apparent. The blue sky peeps out in patches through a murky curtain of smoke, contributed not only by the chimneys of this and adjacent collieries, but by those of thousands of factories and manufactories as well. The high roads are black with the traffic of the coal-carts; and, in dry weather, the wind sweeps along them, driving before it a suffocating cloud of impalpable coal dust.

In wet weather you have to make your way along a slush that reminds you of Day and Martin's blacking! The horizon is obscured by huge hillocks of colliery refuse, which dot the surface of the country, and may be seen wherever a coal mine has been started. Many of them remain to tell of shafts no longer worked, and these are perhaps covered with a thin growth of vegetation, nature having kindly endeavoured to hide the disfigurements which man is continually making on her surface. These hillocks represent the waste material which has been removed, deep down below, in the ordinary course of working the coal seam. It is derived chiefly from that part which overlies the coal, and which is technically called the "roof." Rare places are these hillocks for the young geologist, especially if he work them when the rubbish has been recently brought up to the surface. For, unless he take advantage of that opportunity, the wet and dry weather will soon render any observation unnecessary. The shale which principally composes such hillocks is very sensitive to atmospherical influence, and falls away, or crumbles, in a few days after being brought to the surface; soon becoming a heap of structureless material. But should you go and turn over the newly brought up loads, you will be sure to meet with a perfect harvest of fossil ferns and other plants; fossil fishes, shells, etc., of whose geological antiquity the depth from which they came forbids any doubt.

On the tops of many of these elevated banks you see rising the gaunt skeletons of strong woodwork, supporting pulleys. This is the pit's head, and over the pulleys above runs the iron rope, which is unrolled from the "big drum" in the engine-house close by, down the chasm of the shaft. We ascend one of these hillocks, a feat of no small difficulty sometimes, unless you make your way by the cart-road, for the loose blocks and crumbling shale render the foothold very precarious. Overhead, the wire rope and chains are rattling in a most unmusical and forbidding manner. The mouth of the shaft is covered up by two strong sliding doors, through which is an aperture for the rope to pass. When these doors are drawn away, there opens at your feet a wide black chasm, whose very sight makes you shrink back involuntarily! This is the mouth of the coal-pit, commonly called the "shaft." In all good pits there are two, one termed the "upcast," and the other the "downcast shaft." Were it not for such an arrangement, any accident occurring down this shaft would render the men below prisoners until the obstacle could be removed. Formerly, coal-pits were generally worked, for cheapness sake, with only one shaft, and then such accidents were liable as that which occurred about twenty years ago, when more than a hundred colliers were imprisoned in the bowels of the earth for several days, through the only entrance to the workings being blocked up by an accident. Since Government Inspectors of mines have been appointed, the lives of brave and hard-working men are no longer allowed to be sacrificed to the cupidity of a few colliery proprietors. Another reason for two shafts being required for a coal mine is the better ventilation that can thus be given to the workings. The fresh air goes down one shaft, is conducted to every part of the mine by an ingenious arrangement of pitched cloth, and then the exhausted air is allowed to escape by the other shaft. Down the first of these, the colliers descend to their daily toil. Until the "short-time" arrangement came into force, these poor fellows only saw daylight once a week during half the year! They had to descend in the morning while it was still dark, and did not come up until the evening, when the winter's sun had run its brief race, and darkness once more covered the earth. The blessed Sunday came to them with a twofold light, spiritual and physical.

A strange, independent race, our northern colliers ever were. Half a dozen or more are loafing about the pit's mouth now, with short pipes stuck in their mouths, almost as black as their faces; they eye you very superciliously, and evidently are ignorant of the art of "hat-capping." We will suppose, for the sake of further exploring the ins and outs of a coal mine, that we have an invitation to visit the workings, and hold in our hands an introduction to the manager, or mining engineer. In that case we adjourn to the scanty brick building close by, which is dignified by the name of "office." Some of these "offices," however, are on a much grander scale of luxury, and are fitted up according to the most approved style of mercantile tastes. The walls are hung with plans, and representations of the strata of the district. The mantelpiece is a little museum : here a fossil shell, or fern ; there a piece of spar, or rock ; fragments of the different beds passed through when sinking the shaft. We make ourselves and our errand known to the overseer, or manager, who immediately shakes us more heartily by the hand than we have been accustomed to,—by a hand too, that if measured for gloves would not be fitted by anything under "elevens!" We doff our black cloth coats and silk hats, and fit on, as best we can, some of the garments which are hanging from a long row of pegs in the adjacent hall. The most important article of our new toggery is the miner's hat, made as strong as cast-iron, to protect the head against the stones and fragments of rock, which, at the bottom of the shaft, sometimes come down like hail. Were it not for these hats, and for the thick skulls of their ordinary wearers, many a collier's head would get cracked by the missiles just mentioned. The rough coat you have now replaced your own with is of flannel, with many a stain on it, telling of its former experience. Your trousers are either encased in "overalls," or rolled up and thrust into what we may call a kind of fishing-boots. So far as your person is concerned, you are quite ready for your explorations, and a piece of tallow candle completes your outfit. This is often stuck in the front of the hat, so as to save the trouble of carrying it.

We proceed towards the mouth of the shaft. The "cage," as it is called, in which the colliers descend to their work, has been hauled up, and now rests on the closed sliding-doors covering the mouth of the shaft. Into this we enter, our guide going first. The signal is then given, and immediately the large drum begins to revolve, the iron-rope is strained, and the cage ascends too unpleasantly near the pulleys of the pit-head. But this slight ascent is only made in order that the doors over the shaft's mouth may be drawn away. This is done,—a second's pause, hardly that, and you feel you are sinking. Down you drop, as by the force of gravity, past the doors, and into that terrible chasm! You clutch the hand-railing of the cage with nervous excitement, whilst your feet feel as if they were standing on nothing. Above your head the daylight is getting fainter and fainter, and the opening of the pit's mouth diminishes into a smaller point until it seems to go out like a star, and you are left in thick darkness! The sliding of the cage downwards makes a hissing noise like the slow drawing of the cork of a soda-water bottle. What a time you seem to be sinking! All sorts of ideas as to what may occur cross your mind with terrible vividness. You are hanging in a deep hole, more than a quarter of a mile in depth, and your life depends upon the rope that is letting you down! What if it were to snap,—it is certain it cannot last for ever, and equally so that if it goes on being used it will snap some time! How long has it been in use? Did the manager think it "might run a little time longer" when it was last examined? These wonders are succeeding each other, and suggesting each other, in the deep silence and the thick darkness, when your guide quietly, as if he knew what you were thinking about, draws your attention to the bottom of the shaft. You look, and behold the very faint glimmer of lights. Small and feeble at first, they grow unnaturally larger, and whilst you are watching them apparently increase in size; the cage comes to a full stop, having alighted at the bottom of the shaft as gently as if it had been a falling feather. Men with naked lights, or candles, approach and help you out, and there you are, at the bottom of a coal pit, nearly two thousand feet from the surface; a distance you have dropped in about two minutes!

A dizzy sensation comes across you the moment you get on *terra firma*, and for a second or two the ground seems as if it were rising up before your eyes. This feeling, however, soon passes away, and you look about at the strange world into which you have entered, like the intruding mortals in the "Arabian Nights." From every side of the great hall at the bottom of the shaft (we can call it by no other name) passages radiate in every direction, like so many railway tunnels. Each passage is arched with brick, and the illusion of your being in a railway tunnel is still further carried out by the line of iron rails along the floor. On these run the little coal wagons, called "trams," drawn by good horses, whose comfortable stabling, close by, is lighted with gas. These poor animals, when once they descend the shaft, rarely come up again unless to be put out of the way. After a while they frequently get blind; but until they are useless they are stabled down here, fed here, and doctored here, having bid an eternal farewell to sunlight and green fields! You look into one of the stables: it is cleanly littered, and has all the appearance of a terrestrial stable, but it is much closer and warmer.

The temperature at the bottom of a coal mine is much higher than at the surface, for the heat has been increasing one degree Fahrenheit for about every sixty feet of our descent,—that being the average increase from the surface of the earth towards its interior. In very deep mines, therefore, the heat is almost unendurable, and it forms an unworkable limit to the development of such coal seams as are situated deeper still. You perspire, and so do the colliers, as if you were in a Turkish bath. The gas has been conveyed in pipes all the way down the shaft, and is now carried along the main passages, which are lighted up like large rooms. At the end of one passage is the engine-house. You enter it, and behold a beautifully cleaned and kept stationary engine, whose duty it is to wind up the full trams along the inclines which slope from this level to where a still lower seam of coal is being worked. The floor is carefully whitened, and everything around you bears the appearance of an ordinary well-kept engine-house above ground. The steam-boilers are built into the solid rock, and their furnaces roar unnaturally every time they are fed with fresh fuel, which is every two or three minutes. At the "upcast shaft," situated at the farther end of the workings, another great furnace is kept going day and night, for the purpose of rarefying the air in the shaft, so that it may "draw" the exhausted air in the workings upwards.

Passing along the lighted and bricked tunnels, we frequently meet with half-naked, black, and heated colliers, whose physiognomy it would greatly puzzle you to identify afterwards. At length the gas-lights get fewer, and as we proceed we are lighted only by the tallow candles we carry. The passages are now less finished and more rugged, until we come to a point where we are summoned, as by a military guard, to give up our lighted candles,—"naked lights," as they are termed in mining phraseology. The man is stationed there for the purpose of collecting them, as beyond this the fire-gas, escaping from the worked coal and mingling with the atmosphere, renders naked lights very dangerous. Up to where we have now arrived, it is too much mixed with common air to be dangerous, the only effect being felt as a severe headache by those unaccustomed to breathing the mixture. Each one of the party is supplied with a safety-lamp in place of a candle. What a faint, sickly glare it gives,—hardly enough to make the darkness visible! On either side the solid coal is seen imbedded in the rock, several feet in thickness. It has been worked out where we have been passing along, and these are the "walls" that are left to support the roof. Over our heads stretches the black shale that formerly overlaid the coal. It needs but little observation to see that it is covered with innumerable beautiful specimens of fossil ferns, which any museum would be delighted to possess. Many of these ferns must have been of immense size, for here are the fronds several feet in length. Each pinnule shows the venation and marking characteristic of its kind; and though it is untold ages since it waved in the ancient Carboniferous forests, it is as beautifully preserved as if it had been laid out and kept in a lady's herbarium. Close by, strangely crossing each other and comingling, are the huge flattened trunks of trees, beautifully sculptured and marked, the stems of gigantic club-mosses, such as *Sigillaria*, *Lepidodendron*, etc., or of "horse-tails" (better known to geologists as *Calamites*), that shot up amid the humid flora of the Carboniferous period, scores of feet in height. Here and there are nodules of ironstone, and if you break them open, it is more than likely that you will find some pinnule of fossil fern or shell as a nucleus.

The shells (which chiefly belong to the genus *Anthracosia*) are very abundantly scattered, and strangely flattened, among the shale; and yet you see how nearly they were related to the freshwater bivalves which still love to hide in the muddy bottoms of our rivers and ponds. What a strange history is here stored away in the bowels of the earth, more than a quarter of a mile from the surface! Still stranger does it seem when we are told that the whole of the quarter of a mile in thickness of rock, through which we dropped on our way to the bottom of the coal pit, was equally rich in the *reliquiæ* of former worlds. It is only when brought face to face with facts of this kind, that one begins to appreciate some of the marvellous generalisations of geology, and of the physical changes through which our old planet has passed.

As we proceed farther into the interior of the mine, through narrow lanes where the solid coal has been excavated, we see little doors opening through what appears to be the solid rock-wall, and hear the roar of the currents of exhausted and fresh air on the other side, making their way to and from the different parts of the workings. The question of ventilation is one of the most difficult in mining engineering, especially if the area worked is extensive; and the resources put into use to further this end are very ingenious. The difference in pressure between the rarefied and fresh airs thus being interchanged, is so great that you find it impossible to open one of these doors, unless the current on the other side is first arrested.

At length we reach the farthest part of the mine, the "goaf," as it is technically called, where the colliers are at work. What a strange sight it is to see them. The dim light of the safety-lamps reveals them lying in all positions, their only or chief covering being strong flannel drawers. The short, quick strokes of the pick are accompanied by a plaintive singing of Wesleyan hymn-tunes, for many of the colliers are Primitive Methodists. Others are whistling, or bawling forth tunes of a more secular character, or *swearing*. Little boys are going on all fours, like so many Shetland ponies, drawing away the coal that has been hewn, in small wagons. The shiny coal lies before us in a thick sheet, and all the fuel required to move the ponderous commerce of a great nation like England is obtained by the dim light of these little lamps. Here and there the light is increased by a lambent blue flame within. You ask what it is, and your nerves are not composed by being told it is the much dreaded "fire-damp." Our guide calls our attention to a low, hissing sound, not unlike that made by lemonade after being uncorked. It is issuing out of the solid coal, and is the fearful gas which becomes so explosive and inflammable when mixed with a certain proportion of atmospherical air. The great end of mining ventilation is not to allow it to accumulate, but to sweep it off by a current of fresh air, as fast as it oozes out, to the upcast shaft, where it is either consumed at the furnace or hurried away. Any how it is got rid of. The point at which we had to give up our candles, already mentioned, is that beyond which the mixture of air and fire-damp is most dangerous. Nearer the mouth of the shaft by which we descended, the preponderance of fresh air so dilutes the gas that it is harmless. It is not long before you discover that this fearful enemy of the collier is quite safe when the light is within the safety-lamp, although there is only the thickness of wire gauze between us and a terrible death. Science has stepped in like a guardian angel, and provided a simple, and cheap, and thorough protection against accident. This wire gauze, which is almost red-hot by the flame within, lowers the temperature so that the gas outside cannot be ignited. It requires a temperature of a certain number of degrees to produce an explosion, and so long as this is not present everything is quite safe. We are as safe practically as in our own room, but it is a solemn thought that there is only the thickness of this wiry film between us and destruction.

Meantime, down come the blocks of glittering fresh coals, which are dragged away by the "drawers" as fast as they are hewn out, by sheer muscle and sinew. Many an accident occurs to the brave fellows through whose unenvied toil we are able to sit by our cheerful fire. Sometimes a huge block of coal and overlying rock will come down, and crush a man to death. Often his own longing for a pipe of tobacco will cause him to run the fearful risk of picking the lock of his lamp in order to light it. The collier is so used to danger that, like the sailor, he becomes almost callous to it. All the men working in the dangerous parts of the mine are dependent for their general safety upon the rashness or carelessness of any one of their mates. Another danger is the common lot of all of them. Sometimes in hewing out the solid coal, they will come on great hollows, called "blowers," full of fire-damp. When these are tapped, out rushes the fatal gas, unchecked by the ventilating current; and then, should the explosive mixture extend to the naked light limit, one fearful ring is heard, a great sheet of blue light flashes simultaneously through every part of the mine, and a more than Egyptian darkness succeeds. The equally fatal "black-damp" rolls along the floor, and our coal mine becomes a subterranean sepulchre, containing the mangled and unidentifiable bodies of perhaps hundreds of men and boys. Such is a picture of what occurs nearly every year, when the dark days of November crowd upon us, and the atmospherical change favours the more rapid disengagement of fire-damp from the coal seams. These "blowers" may be as old as the coal itself, having been caused by the contraction of the vegetable mass as it passed into its present mineral condition. They are fearful liabilities, and some seams of coal are more threatened by them than others.

In following the course of a seam of coal, often at an inclined angle, called its "dip," miners will come upon a "Fault." This word is applied to the phenomenon of the coal coming to a sudden termination. These "faults" are always indicative of great plutonic dislocations of the solid strata of the earth's crust. The rest of the coal seam thus missing may be hundreds, perhaps thousands, of feet above or below the point where it has been broken off, and not unfrequently a chasm several feet wide separates the walls of solid rock that have thus been rent asunder. Very often these "faults" serve as great natural drains for the country above, and then, when reached and broken into, they may flood the mine from end to end, and drown the men. Sometimes they are filled in with clay and rubble that have fallen down; at others they are simply empty, dark chasms, stretching deep down below into unfathomable profundity. You may perhaps see the walls on either side the "fault" polished and rubbed smooth where they have been in friction against each other. On the upper surface, if it had remained in the condition left by these dislocations and upheavals, you would now have a series of steep precipices as abrupt as any in the Alps. But in the geological ages that have elapsed since this disturbance took place, all these inequalities have been pared down, and the material carried away to form strata of a later age. But still, in Lancashire and Yorkshire, some of the hills are related to the lines of "fault."

This, however, is not the place to treat further on such phenomena, wonderful though they be. And by this time the constant stooping has produced an unpleasant "crick" in your neck, and the poisoned gas and close hot atmosphere have produced a racking headache. So you are not disinclined to leave these subterraneous regions for fresh air and warm sunshine, which never feel so grateful as after four or five hours in a coal mine.

CHAPTER X.

PHOSPHATES: THEIR ORIGIN AND USES.

DOUBTLESS many of our agricultural readers who have "eaten their terms" at Cirencester need little instruction as to the uses and circulation of phosphates in organic nature. But there are scores of farmers with no claim to a knowledge of geology or chemistry who are continually coming into contact with vendors of artificial manures, in which article phosphates form (or *should* form) the most important ingredients. If such farmers don't use phosphates themselves, their neighbours do. They hear of them at the market and in the railway train, and are surrounded by advertisements recording their wonderful fertilising and stimulating properties everywhere.

It is for such people that we venture upon the following remarks, which are intended to set forth the real uses of phosphates in agricultural operations.

That this mineral performs very important functions in the animal economy all physiologists are agreed. As at present constructed, the power of thinking which the brain of man possesses appears to be somehow related to the quantity of phosphorus which enters into its material composition. And as the increase takes place in human brain power, it follows that foods containing the necessary phosphates will be in increasing demand. But not only is phosphorus necessary to the well-being of the higher animals—it is scarcely less so to such plants as the cereals and leguminous or podded-plants, like peas and beans, and, indeed, to seeds in general. By a peculiar natural selection, of which we have no historical account, the vegetable food of man has come to be composed of just those plants, or parts of plants, which naturally contain most phosphates, such as wheat, oats, rye, barley, maize, peas, etc.

For some time back there has been a great necessity for agriculturists obtaining from British soil as much as they possibly can; and agricultural operations have been gradually rising to high-pressure pitch in this respect. It will be our endeavour shortly to show that the most fertile stimulants to the producing powers of English soils are brought from other countries, so that the land in Great Britain is getting very much mixed, and in time it will be called "British soil" only as a figure of speech! What is known as "manuring" is, after all, only an endeavour to give back to the soil those elements which have been taken from it in the substances of the crops. If they were not put back, the soil would soon become barren. The richest hoard placed in a bank will become less if it is constantly drawn upon. The abundance of crops must, therefore, in a great measure depend upon whether the soils contain the necessary quantity of fertilisers. When we remember the quantity of phosphates which are taken out of our English soils by the crops we raise, and that this process has been going on for a thousand years, ever since the period of Saxon occupation, it is evident that these soils must have long ago had all their fertility drawn out of them, unless much of it had been replaced by manures. Some people seem to imagine there is a peculiar mysterious fertility in "good muck." But "good muck" means that the manure contains what the soils in which we intend to work it really require. Farmyard manures (the genuine and fondly-regarded "muck" of the old British farmer) only contains phosphates, etc., in a limited degree; but the "four-course system" has at any rate preserved our soils from barrenness by prescribing what crops and manures shall be used. And of late years no farmers, have more clearly seen the advantages to be derived from the use of genuine "patent manures," or fertilisers more abundantly rich in nitrates and phosphates than the best farmyard muck can possibly be, than the Scotch. Both natural and artificial manures have been used, as a rule, so rationally, that the East Anglian soils are possibly more fertile at the present time than at any previous period in English history!

Soils may be said to possess two kinds of fertility—their *natural* and their *acquired* fertility. The former is that which the cultivator finds when he first comes to till the virgin ground—the latter, or acquired fertility, represents the amount of manurial wealth which has been put into the soil. In Nature phosphorus never occurs in a pure state—it is always combined, generally as phosphoric acid, with some base. It is present in most igneous rocks, and volcanic soils owe much of their exceeding high fertility to the greater diffusion of phosphates among them. In the flesh of animals phosphorus seemed to exist as a phosphate of magnesia or potash; in bones as a phosphate of lime. It is in the condition of phosphate of lime, however, that this important element appears to be most acceptable both to animals and plants.

We have said that phosphorus often occurs in a combined state in Nature. That is true. There is phosphorus enough and to spare. One of the chief difficulties for some time back in the iron manufacture of Cleveland has been to get rid of the phosphorus which rendered the iron so "short," or brittle. In igneous rocks, such as granite, green crystals of *apatite*, or phosphate of lime, frequently occur. This is the purest condition in which it can be naturally produced. In Canada there is a bed of this valuable green *apatite* ten feet thick, the three feet of the middle of the vein being nearly as chemically pure as it can be. In England the discovery of phosphates in certain strata has opened out a new industry and a new source of wealth. They occur, in greater or less abundance, in nearly every geological formation; although they have seldom been worked at a profit except in the upper and lower Greensand formations at Farnham, and in Bedfordshire, Cambridgeshire, and West Norfolk, and at the base of the Red-crag formation in Suffolk. In Germany the phosphates occur as deposits, filling up hollows and fissures in Devonian limestone rocks, and it is not difficult to see how these valuable deposits of phosphate have thus been accumulated. The limestone rocks are either now covered over with a thick sheet of volcanic ashes, of much later geological date, or they have been. The volcanic ash contains about one-half per cent of phosphate, which has been dissolved out by percolating water and carried down into the hollows and caverns of the limestone rocks beneath, often completely filling them up.

The phosphate deposits of the South of France (which we have already described) are both geologically and commercially of the greatest importance. Indeed, from a geological point of view, we know of none to be compared with them in interest. They are also found filling up what had once been great caverns and wide fissures in the Oolitic limestone rocks. In many places we can see that the phosphate of lime (or *phosphorite*, as it is now scientifically termed) has been deposited layer upon layer, like the coats of an onion, upon the walls of ancient caverns, until the latter have been completely filled up. This phosphorite varies from 90 per cent nearest the limestone to about 30 farther away towards the middle of the "caves." The fossil bones and teeth found associated with the phosphorite are well known to geologists, who are able to tell the exact period at which the animals to whom they formerly belonged lived and moved and had their being. It was the period known as the Miocene, when over this area of France enormous herds of wild animals roamed and left their skeletons to bleach upon the surface, just as we read of the whitening skeletons of the bisons on the prairies of America. Now, the bones of animals contain 55 per cent of phosphate of lime, so that when the skeletons of these ancient animals were exposed to the action of the weather century after century during a prolonged period, the phosphate of lime of their bones was gradually dissolved by rain water, which eventually found its way along chinks and fissures of the limestone into the caverns, where the phosphate was deposited. At times the bones themselves were carried down into the caverns, just as the carcases of sheep now are in the "swallow holes" of the Yorkshire moors. It is something after this fashion that the rich and abundant deposits of phosphate in the South of France have been formed, and thus it is that when we use them in our artificial manure we are in reality utilising the bone-dust of pre-Adamite animals!

The well-known Red-Crag phosphates of Suffolk are scarcely less interesting to geologists than those just described. They occur as lumps or nodules, often enclosing fossils; but, singularly enough, these fossils are never those of the Red-Crag itself, but always those of the much older London Clay formation. These Crag phosphatic nodules still go by the name of *coprolites*, from an antiquated but erroneous opinion that they are the fossil dung of animals. Instead of this being their origin, however, we know that they represent that portion of phosphorus which has entered into the structures of the *soft* bodies of those very animals whose hard parts, bones, shells, etc., also occur in the fossil state—phosphoretted hydrogen, set free from the decomposing bodies of the animals which died in the sea, along whose floor the London Clay was deposited. Phosphoric acid so forming combined with lime, and in this manner the little lumps or nodules of phosphate of lime were formed by segregation. After the same way the flint nodules were formed in the chalk. The fossil bones, teeth, and shells found in the Cambridgeshire and Bedfordshire Greensand beds represent derivative fossils from two or three subdivisions of the Oolitic formation, and at present the origin of the so-called Cambridgeshire "coprolites" is not exactly known, although there is little doubt it was similar to those of the Crag. We seldom meet with undisturbed and underived phosphatic nodules except in clayey strata; hence in the Silurian, Carboniferous, Liassic, Gault, London Clay, and other formations of this nature, we invariably find phosphatic nodules. When these clayey beds are destroyed by wear and tear the nodules are liberated.

The fact that phosphates are formed as the result of all kinds of animal life in every geological period indicates their necessity in animal economy. On the dry land, whatever phosphates may be present are being slowly dissolved away. In virgin forests the soluble minerals migrate from the soil up into the tissues of the plants, and when the latter die the same minerals are returned to the soil again. When rocks contain phosphates, as they weather they yield such phosphates to the soils formed by their waste. During that last of the extensive geological periods called the Glacial Epoch, just before man appeared on the earth, all the hilly rock masses in the north,

north-east, and north-west of Great Britain were much broken up and pounded by ice-action, and the *débris*, or materials, were strewn over the sea-floor. That sea-floor is now North-Western, Midland, and Eastern England, and the *débris* are the rich "heavy lands" or "Boulder Clays." So far, therefore, we find ready mixed to our hands a rich soil naturally containing phosphate derived from the broken-up igneous rocks.

If we are to obtain rich crops of cereals, it can only be done by enriching the soils which are to produce them with the minerals necessary to their growth. An analysis of the different conditions of the different stages of the growth of the young wheat-plant shows at once that phosphorus must be of great importance to them. Thus, when a wheat-plant is in its youngest stage of growth—say, when it is budding its first pair of leaves, the amount of phosphorus contained in it is very small. When the plant has grown to half its natural size, the amount of phosphorus is proportionately greater. When it begins to form the "ear," the amount has increased still more; and at last, when the seed-grains are fast ripening in the "ear," it seems as if all the phosphorus of the plant were drained to that part. The pollen of all flowers contains phosphorus, and as wheat, barley, etc., are what are called "wind-fertilised plants," they have to secrete more pollen than is absolutely necessary in order to have enough for the wind to carry about, and thus ensure proper crossing and flowering. Hence there must be a great drain upon and waste of phosphorus in these plants at the time of flowering. Phosphorus in the soil is absolutely necessary to such plants if they are to secrete sufficient pollen, and sufficient pollen means having every flower of every "ear" fertilised, and the "ears" completely full. As wheat-grains ripen, phosphorus is drawn to them both from every part of the plant and the soil as well; so that the wheat-corn is found to possess the maximum quantity. It is this which so peculiarly fits wheat to be the staple food of civilised, brain-working man!

We have said enough, it is to be hoped, to show the necessity for phosphorus to be present in some form or another, if all the functions of cereal life are to be prosperously performed. When we drill artificially-prepared phosphates in our soils, they are in the condition known as soluble, or *superphosphates*. These superphosphates are composed (when *genuine*—a very important matter to have determined) of a mixture of sulphate of lime, and mono-calcic, di-calcic, and tri-calcic, phosphates of lime, in which, however, the mono-calcic phosphates should prevail. The phosphate is now soluble, or nearly so, and ready to be absorbed by the roots of plants; although, if the soils contain much iron, a good deal of the phosphate will be precipitated in an insoluble form. It is therefore of great importance that farmers should know something of the nature of their soils before they apply these phosphates, as well as of the crops they intend to raise. Clover, for instance, does not require so much phosphate as turnips or peas, or barley and wheat. But even though a portion of the superphosphates used in artificial manuring must be converted to an insoluble condition in the very best of soils, there is little doubt it may be slowly obtained from it in subsequent years, for the delicate roots of plants have the power of making phosphate of lime once more soluble, even from its precipitated condition. This was proved by Professor Sachs, who obtained polished slabs of phosphate of lime, and covered their surfaces with a little moist sand, in which he planted seeds. The seeds germinated, their roots struck through the sand, reached the polished surfaces of the phosphate slabs, and there dissolved out such quantities as they required, leaving on the polished slabs an etched outline of the work that had thus been done.

It should be remarked that lime seems to act as a kind of *carrier* of the phosphorus which plants need ; for phosphorus is found in a plant, although lime may not be present, even when the two had been previously combined in the applied superphosphate. Phosphate of lime, therefore, seems to be the readiest condition in which to place phosphorus in the soil for the use of plants.

A good deal has been said lately as to the value of potatoes as a crop to British farmers. Although the too great use of the potato has been decried by some physiologists, there can be no question as to the beneficial use of this vegetable, especially to brain-workers, for the potato contains phosphoric acid, which is present, however, in the largest percentage in potato-skins. Consequently, phosphatic manures are nearly as important to potato crops as to cereals. The bones of animals are in a constant state of replacement—of being taken down and rebuilt with phosphate of lime. The removed phosphates are carried off in the dung of such animals, and it is these which give to their *fæces* their manurial value to the farmer. In man, however, similar waste phosphates are carried off in the urine, so that animal manure is of greater manurial value than night-soil, notwithstanding the opinion to the contrary.

In Nature there is almost as perfect a circulation of phosphates as there is of water and air in the ocean and the atmosphere. There is the same amount of phosphates in existence now as there was when Life first appeared on our globe and made its original demand upon them. These phosphates are as necessary to the healthy and prosperous well-being of the animal and vegetable kingdoms now as they ever were. They have, as geology proves, entered into the structures of creation after creation of extinct animals and plants, and have been left by them in the rocks and the soils as a legacy to the later-comers. Much of these phosphates are now locked up in the mineral condition, abstracted from active circulation, and it is the duty of science to set them free and render them available to the use of man.

CHAPTER XI.

VULCAN'S FORGE.

VERY few subjects are so little known, even among intelligent people, as the real nature of earthquake and volcanic energy. Any one who has travelled in the mountainous regions of North Wales, the Lake district, or Scotland, will have heard people glibly talk of the earthquake violence which must have rent and cleft the hills to form such passes as those of Llanberis, Borrowdale, and Glencoe. Any gorge or ravine, unusually steep or rugged, is by them ascribed to earthquake agency, without the slightest endeavour to find out whether it is so or not; and in many instances without their having any previous knowledge of the real nature of such agency to enable them to form a trustworthy opinion. The fact is that such scenic phenomena as we have just referred to are not in any way due to subterranean action, but to weathering. Although the rocks forming the dry land of Great Britain are in many places crowded with evidences of earthquake and volcanic phenomena, these are known chiefly to geologists. They present few external features by which they may be popularly known.

Perhaps there is not a square foot of the earth's surface which has not, at some time or another in the geological past, been affected by earthquake or volcanic influences. We have learned something of the laws of these much-dreaded agencies, and, as is usually the case with natural phenomena when they are better understood, our ideas of Creatorial wisdom are considerably elevated. Not many years ago it was firmly believed that earthquakes and volcanoes were evidences of divine wrath ; now we know that without them our planet could not have possessed its scenic diversity of mountain and valley, ocean-bed and table-land. Moreover, it has become plain that, had it not been for the continuous and varied operation of these dreaded forces, the influence of solar energy exercised through atmospherical agencies, would long ago have dissolved away every prominent feature, and have reduced the surface of the globe to one uniform level! As it is, the uplifting of rock-masses by earthquake forces, and the accumulation of lava-streams and ashes into conical volcanic mountains, have kept up the variety in physical geographical aspects which would otherwise have been speedily obliterated.

What is the nature of those wondrous forces which seem pent up in the interior of the earth, which break out every now and then like wild beasts, and ravage some of the finest tracts of the earth's surface? Viewed from the narrow point of personal disadvantage, one cannot be surprised that such visitations should be regarded as tokens of divine anger. But the world is gradually coming to believe more in a God of love, "slow to anger and of great mercy," and science is undoubtedly helping it to do so. The latter has taught us to see in earthquake and volcanic agencies *preservative*, not *destructive*, forces; without them our planet could not have lived out half its days; we should have had few or no mineral or metallic veins, and by this time, if there had been any land surface at all, it would have been as flat as Holland, the whole world over! To make ourselves as plain as possible, let us suppose two forces at work, each checking the other's influence, and yet both necessary for the production of a certain end. One we will call *solar*—it resides in the sun, it is manifested as heat, produces winds, lifts vapours, and thus brings about all those agencies of the weather which we know are constantly denuding the irregular surfaces of the dry land. Were this force to be alone in its operation, it is evident that in time the irregularities would be all removed. But we have another, resident in the earth itself, which we may provisionally call *terrestrial* force. This is manifested in volcanic outbursts and earthquake disturbances. It becomes apparent when we descend deep mines, and the heat increases in a certain regular manner. All the mountain chains of our globe have been formed by it, and not a few of the troughs of our deep seas. Its tendency is to produce an irregularity of surface as opposed to the uniformity which, we have seen, would be the result of solar force acting alone.

And yet both these forces, that of the sun as well as that of the earth, had a common origin. We have an explanation of the latter in the Nebular theory, which teaches us that once in the dim history of the past, all the planets and satellites of our solar system, as well as the sun itself, existed as a cloudy dispersed mass; that subsequently this was condensed into planets and their satellites, the main mass being central to all, and forming the sun. All the planets were then so highly heated that they shone with their own light, and were in the same physical condition as the sun still is. Indeed, the reason why the latter is so hot is because of its enormously greater mass (more than a million and a quarter times greater than that of the earth), and the longer time it will take to cool. The smaller planets, and especially their moons, cooled down first. Our moon has long ago lost its heat. Hence it is a lifeless, waterless, atmosphereless world—a prophecy of what our earth one day will be, just as the sun is an illustration of what our globe formerly was.

It is a well-known fact that solid bodies are affected in their bulk by heat and cold. They expand by heat, and contract by cold. The iron tubular bridge across Menai Straits expands and is elongated more than a foot by the heat of an ordinary summer's day. Had the engineer made no allowance for this, the entire structure would have loosened and brought itself down. Now the same law applies to our globe. As it has cooled down from its original, perhaps molten condition, it must have contracted in size. It is therefore less in diameter now than it was then. But as it cooled a crust formed. This must have protected the heat in the interior, although it could not entirely prevent some of it being constantly wasted. And as the interior shrunk, the crust of the outside must be contracted also, otherwise our planet would be like a ripened filbert, in which we can hear the kernel rattle inside the shell. It is this constant contraction of the rocky crust of the earth into a smaller space which has folded the older rocks (and therefore those which have been subjected to most physical changes) into the contorted condition they present in most mountain regions. The strike of mountain chains is nothing more than the direction taken by the chief foldings produced by contraction of the crust. These foldings have always been going on, as the earth has lost heat, and so our mountain chains are of various geological ages. The roughened appearance of the surface of our planet, therefore, is like that of an apple which has been kept in some cupboard, until it is dry and has lost its moisture, so that its skin is furrowed all over into folds which intersect each other.

There can be no doubt that every contraction of this outer crust to the gradually shrinking interior, is accompanied by heat produced by the crushing and friction. Where the crust is thinnest and weakest, a fracture may take place, like the "faults" which geologists know are so abundant everywhere in the older rocks. The force generated by fracturing or folding of the crust is that which produces the much-dreaded earthquake shocks. When this force is very intense, it may pass into *volcanic* energy, for it has been shown that a contraction of the entire crust of the earth, to the amount of one twelve-thousandth part of an inch, would produce as much heat as is evolved during an ordinary volcanic outburst! Few earthquake shocks originate at a greater depth than thirty miles, and most of them at much less than that depth from the earth's surface. The thickness of our planet's crust, although a matter of dispute, cannot be so great. As we descend a deep mine we find the heat increasing one degree for about every sixty feet. If it actually increases at this rate, it is not difficult to calculate what depth we should have to go to find a place where all the substances must be in a state of fusion, unless prevented by the pressure of gravitation. Indeed, from the crystalline character and other evidences we have in the older rocks, we know that the latter must once have been subjected to greater heat and pressure than they are now. Supposing the crust of the earth to be one hundred miles thick, this would bear little relation to the diameter of the globe. The latter is eight thousand miles, so that the greatest estimated thickness of the crust would be only one eightieth part of it. We can form a better idea of this relation by the following illustration. Suppose we take a book having one hundred and sixty pages, and tear out a single leaf. It would be utterly impossible for the eye to detect from the thickness of the closed book that such a leaf had been extracted. And yet this would represent the disappearance of the entire crust of the earth, from one side at least! We can therefore see how immense are the forces acting upon a thin, solid, and to a large extent irrefrangible part. No wonder that the primary rocks are so metamorphosed, folded, and faulted—the wonder would have been otherwise if they had not been, when we consider the contractions suffered by the earth's crust, during the slow loss of heat which has been going on in the millions of years which have elapsed since the dry land was first separated from the waters.

When a shock is produced by such a contraction or fracture as we have been supposing, a wave of force is generated which travels along the adjacent rocks as a wave travels along a slack string when the latter is struck, or as when a series of concentric waves roll away from the point where some stone has been cast into a still and deep pond. The outer waves, in the latter instance, become weaker the farther they recede from the central point of disturbance. So it is with earthquake waves—they become fainter farther away from where they originated. We in Great Britain are far outside the great circles of earthquake foci at present, although we were not always so, and consequently all we feel of them is just sufficient to arouse scientific curiosity. Sometimes an earthquake shock will be generated in that part of the earth's crust whose upper surface is occupied by the ocean. The great Earthquake of Lisbon was of this character, for the shock occurred under the floor of the Atlantic, and travelled thence, so that Lisbon was the first city visited by it. The waters of the ocean were affected by the shock like the rocks of the earth's crust, but the earthquake tremor could not travel so easily through the water as through rocks, and so the great water-wave, sixty feet high, followed on slowly afterwards and found the terrified Lisbon people gathered on the quay, away from the falling houses, and it swept them off by thousands! It has been calculated that the earthquake waves on this occasion travelled at the rate of twenty miles a minute.

It has long been noticed, in centres of volcanic disturbance, that earthquake shocks always preface the outbreak of volcanic energy, and seem to pass into it, so that when a volcano begins to discharge, the earthquake forces are quieted. There can be no doubt that these two forces are identical in their origin, and that their separate manifestations are mainly due to different modes and degrees. Not unfrequently sufficient heat may be generated by the crushing of deep-seated rocks during a folding of some part of the crust, to melt a portion of the rocks into lava, or even *granite*, if the overlying pressure be great enough. All our volcanoes are found in areas of *upheaval*, all are found belting sea-coasts except Demawend, and as that is situated on the shores of the Caspian, it rather bears out the general rule than not, that volcanoes, to be active, must be situated near large bodies of water. From the great quantities of steam given out during volcanic discharges, it is evident there must be some immediate connection between the water and the heat which converts them into steam. A volcano was formerly believed to be formed by a tension or blister-like swelling of one part of the earth's crust, until the strain caused the upper part to crack and burst, and then the lava and ashes were discharged. This idea only lingers now in antiquated geological books.

The keen examination, collection, and comparison of facts during the last thirty years has for ever settled the question as to the origin and growth of volcanoes. A star-shaped fracture or crack is first made, up which the molten matter we call lava emerges. This accumulates around the vent or crater. Successive outbursts, extending it may be over hundreds of thousands of years, raise the conical mound by their accumulating layers until it becomes a mountain. The area where such a volcanic mountain has been forming has been unlifted in the meantime, for we have seen that volcanoes are everywhere situated where the earth's crust is rising, until eventually we find the mountain crater at a considerable height above the sea level. Mount Etna is a case in point. At the time when our Suffolk Crag beds were forming, which is comparatively recent from a geological point of view, this volcano had not commenced its existence. Now its top is nearly eleven thousand feet above the level of the sea!

When the force which lifts the streams of lava to the mouth of the crater is excessively energetic, it may actually blow the lava into dust, and raise it to an enormous height in the atmosphere, mixed with steam and the flames of gases. It then descends as "volcanic ash," but the upper atmospheric currents may carry such ash hundreds of miles away from the source of ejection. Ashes from Central American volcanoes have thus been carried as far as Jamaica.

Some volcanic mountains are formed chiefly as accumulated heaps of such ashes, like those of Java. When the successive discharges of volcanic matter have caused a mountainous heap to accumulate so high that the forces within can lift it no higher, the volcano will either break forth at the side, and form lateral craters, or will temporarily rest. Some other fracture of the earth's crust at no great distance elsewhere may draw off the energy; and thus a volcano gradually becomes extinct, the signs of its senility being the discharge of hot mud, hot sulphur springs, naphtha, etc.

The areas of volcanic manifestation have always been changing. Thus we find in North Wales and Cumberland the *hearths* of volcanoes which must have been terribly active in Great Britain during the Silurian epoch. During the Carboniferous period there were volcanoes in Derbyshire; in that geological age known as the Miocene, Europe was especially visited by volcanic action. The Isles of Mull, Rum, Eigg, etc., in the Western Hebrides, are nothing but the weathered and truncated bases of volcanic mountains which were then active, and which Professor Judd believes were ten to fifteen thousand feet high. From them issued those streams of lava which shrunk into the columnar pillars of Fingal's Cave and elsewhere. In the north of Ireland volcanoes were active at the same time. You can still see, in the coast sections, near Portrush, the old pipes up which the volcanic matter rose and accumulated until it covered nearly the whole of County Antrim. The Giant's

Causeway is part of one of the old lava-sheets. In Central France we have one hundred and fifty extinct volcanoes, whose shapes have been marvellously preserved, so that we can still trace the direction taken by the ancient lava streams. On the Rhine we have the Siebengebirge, which are extinct volcanic mountains of the same geological period, whose mineral springs still testify to the former subterranean activity which was here manifested.

Thus has the continuously altered crust of the earth been cemented together by the iron bands of volcanic energy. New formations have always been, and still are, going on, and the same subterranean activity converts these into dry lands and continents. There is hardly a square mile of the solid land which has not been formed along the floors of ancient seas, and had it not been for the *terrestrial* force we spoke of, this could never have been uplifted to the place we find it occupying. To the reverent mind, therefore, which can extend its vision across the geological past, and take into account the numberless agencies which are required to keep a planet in healthy activity and fit its surface to be the abode of life, these dreaded volcanic and earthquake energies will no longer appear otherwise than as "ministering spirits," doing necessary work in the physical well-being of the planet which we inhabit. Without volcanoes and earthquakes it is more than probable our little planet would not have lived out half its days. Every shock and outburst, therefore, means a new lease of life to the earth.

CHAPTER XII.

THE GEOLOGICAL DISPERSION OF ANIMALS AND PLANTS.

FEW subjects are of broader interest to naturalists than this; although it is surrounded by much that is vague and disconnected. The various facts have only fallen into harmonious arrangement since the publication of the *Origin of Species.* Darwin may well claim that only from his point of view can the subject of the distribution of animals and plants be scientifically treated. The manner in which this question has been taken up by naturalists all over the world shows the influence which a great mind has over its fellows. Natural history has received a similar impetus under the Darwinian theory that astronomy did under the old Copernican.

Thanks to the rapid progress of science, it is now possible to briefly review the subject of the distribution of existing animals and plants, in the light both of palæontology and of those geological operations which have produced such enormous physical changes on the surface of the earth. It is now plainly seen that the relations of the existing fauna and flora to extinct species are more intimate as we approach the present epoch. Indeed there is no fact in modern geology so generally admitted as the impossibility of severing the various groups of existing animals and plants from those of bygone ages. As most of our readers are aware, these ages are usually grouped under three great divisions, relatively termed the Primary, Secondary, and Tertiary. These names indicate their relative antiquity. Each division is provisionally subdivided into epochs, and thus the geological nomenclature is made up. Even before Darwin advanced his views, the principal naturalists saw that the life-systems of these various stages were related to each other, and together form one grand total which might be regarded as the biological history of our planet. Of these systems the existing one is the last, and bound to the rest by lines of descent. These lines can be traced far away to the dim Laurentian age; but they are strongest as the geological student ascends the geological scale towards the present time. The most stubborn of anti-Darwinists has to confess that the Tertiary species of animals and plants, relatively few though they be, are nearly related to their present representatives.

Geology has passed through many social phases in its brief history. The classification of Comte is certainly correct when applied to stony science. It has existed simply as a catalogue of *lusus naturæ*, just as astronomy was hidden under the form of astrology. Then it emerged into daylight, only to be the butt of theological animosity and ridicule. Gaining strength by its grasp of facts, it had subsequently to be ill-treated at the hands of its friends under the form of "Reconciliation" theories, until, like the infant Hercules, it strangled the snakes in its cradle, and has arisen to impress its indelible influence on almost every phase of modern thought. Unfortunately, the idea that the various geological periods were marked by distinct life-forms—the product of the earlier French school of geological thought—which were successively created and destroyed, has not yet completely died away. There are not wanting a few eminent naturalists who still cling to this idea, although their number is every year becoming less. The natural corollary from such an idea is that the *present* creation of animals and plants is also special, and the result of a separate and distinct Creative power. Let us endeavour to show the fallacy of this notion, and to bring to bear upon it the most recent investigations in natural science. We are obliged also to deal with a commoner but equally gross mistake—viz. that the earth's crust contains no "missing links."

To no science is geology more indebted than to zoology. Only by its aid have geologists been able to understand the exact relations of extinct to living forms of life. Numerous though these fossil species are (the rocks of Great Britain alone having yielded nearly fourteen thousand), we are forced to conclude that all are reducible to the same orders and classes as their modern representatives. The natural history classification intended to embrace the recent fauna and flora, will equally include the fauna and flora of every period of the earth's past history. This proves that the plan of their construction, at least, has never been altered. In numerous instances, extinct forms have enabled the naturalist to render the classification more complete, by filling up the gaps which before existed, and thus drawing the various orders and classes nearer to each other. Recent researches in palæontology and zoology have been travelling towards the same goal from opposite points. The former has been multiplying the list of existing species found in the fossil state, and the latter has been bringing to light the fact that many so-called extinct forms are still living in abysmal and unexplored depths of the sea. We have referred to the great benefits which geology has conferred on geological science, especially in the earlier days of its history; geology has now arrived at a maturity and strength which enables it to repay its foster-mother the debt it owes. From the knowledge of its organic remains zoologists have been able to understand many a problem which before was incomprehensible. Its latest act of filial gratitude is to assist naturalists in accounting for the geographical distribution of animals and plants. Not many years ago this was their greatest difficulty. Even the gigantic intellect of Humboldt had to be content with guessing at a truth which has only been clearly made known since his death. The occurrence of animals and plants so *unlike* each other in districts where the physical and geographical conditions were so similar, might well prove a hard nut for non-geological naturalists to crack. It has been the necessity of seeking the lineal ancestry of existing species in the geological epochs approaching most nearly to our own, which has shown us what modifications and migrations many species have passed through during the slowly-changing physical conditions.

Instead of regarding the present animal and vegetable populations of the globe as a distinct and synchronous creation, definitely separated from any that went before, we are compelled by the sheer weight of facts to regard them as the direct results. The secret of their present geographical distribution and isolation, apart from the laws of natural selection which have been in operation, is to be found in an intimate knowledge of the geological changes which have taken place since certain families of animals and plants first made their appearance on our globe. It is well known that the farther we go back in geological time, to study the different kinds of animals and plants, the more are we struck by their *unlikeness* to the species now living. The primeval forms have been thrust aside by others better fitted to take a leading position in the battle of life. Analogous functions have been formed by successive and distinct groups ; a few types, however, have stood the heat and burden of the fight. They bear much the same relation to existing animals that the Celtic words in our language do to the Saxon, Danish, and Norman, which subsequently overlaid them. One geographical peculiarity is always true of these ancient groups,—they exist in widely severed latitudes. The most striking fact, perhaps, in the whole life-history of our planet is that the farther we go back in time, the more lowly organised are the species, whether of animals or plants. Now it is exactly such forms which have had the greatest geological antiquity. Whilst one type of specialised organism after another has passed away, the humbler species have maintained their ground unchanged, or nearly so, in organisation. It is the moral of the oak and the reed ; the storm which felled the former has simply beat the latter to the ground, to spring to its original position after the blast has passed away. These lowly organised types have now the most cosmopolitan distribution, so that in this respect they resemble those higher forms which have a high geological antiquity.

Among the lichens brought by Sir James Ross from the high latitudes of the Southern Hemisphere, the greater portion were found to be specifically identical with those growing in Europe. Professor Owen mentions one species of Foraminifera (*Webbina rugosa*) which has continued in existence since the Liassic period. The following are among the commonest genera of fossils, on account of their geological antiquity:—*Nautilus*, *Terebratula*, *Rhynchonella*, *Lingula*, *Mytilus*, *Modiola*, etc. They have had a continuous range of existence ever since Silurian times at the least. During the Primary epoch the commonest and most widely distributed fishes were the Ganoids, an order distinguished by being covered with enamelled bony plates instead of horny scales. This dominant group gradually dwindled during the latter stages of the Secondary epoch, and was replaced by other orders, which are now cosmopolitan as the Ganoids once were. But there still exist what we may term "outliers" of this ancient fish fauna, in the Bony Pike (*Lepidosteus osseus*) of North American lakes and rivers, and in the *Polypterus* of South Africa (found abundantly in the recently discovered great lakes). The "Mud-Fishes" (*Ceratodus*) have been found still living in the rivers of Australia, although they occur in the fossil state in our

Rhætic beds on the banks of the Severn. Our common Sturgeon is nearly related to the interesting order of the Ganoids. Dr. Günther says they now form only three and a half per cent of known species of fish. The widely isolated character of this group of fishes plainly indicates its antiquity, and as surely foretells its ultimate extinction. Taking into account its former widely diffused condition, is it not evident that the isolated areas it now occupies are mainly to be ascribed to those subsequent geological changes which have broken up a once cosmopolitan fauna into these satellary fragments? Again, so far as is yet known, the only warm-blooded animals which lived during the entire Secondary epoch (with the exception of such rare forms as the *Archeopteryx*, half bird and half reptile, with its allies) were Marsupials. They became extinct in Europe during the Mid-tertiary or Miocene period, although we still find them living in lands as far apart from each other as North America and Australia. In the North American Oolitic strata fossil species have recently been discovered, and there is every reason to believe that the existing Opossums of that country are the lineal descendants of the Oolitic forms. The greater part of Australia appears to have been dry land since the close of the Secondary age, at the least, so that its characteristic modern mammalia may be traced thus far back in time. The Australian cave breccias yield gigantic extinct forms of the same order, and no other. In America the Opossums belong to the Marsupialia, and their peculiar features, when compared with those of their Australian representatives, only too surely indicate the immense period of time which has elapsed since they were blood relations! Another illustration from the more ancient formations, and then we will proceed to notice how the lineage of existing forms becomes clearer as we come to the Tertiary epoch. A very large number of Secondary *genera* of shells are still in existence, among which are such well-known forms as *Tellina* (which then first appeared), *Cardium*, *Turritella*, *Pyrula*, *Nassa*, *Natica*, *Solen*, *Trochus*, *Pecten*, and a multitude of others. But one special illustration. In the upper English Chalk strata we meet with a species of brachiopod (*Terebratula lineata*) which the best palæontologists recognise as identical with the existing *Rhynchonella caput-serpentis* of our British seas. The antiquity of the latter species might have been guessed at from its peculiar geographical distribution. It is common to both sides of the Atlantic, as well as to South African and Chinese seas. This wide severance of areas from each other, it cannot be too firmly insisted upon, is in every case illustrative of the antiquity of a species. Dr. Carpenter and Professor Wyville-Thomson believe we are still living in a Cretaceous epoch, owing to the Cretaceous *facies* of the abysmal fauna of our great oceans, from whose beds, during the recent "Challenger" Expedition, such well-known Cretaceous fossils as *Salenia* was obtained in the living state. Thence also was dredged *Calymne relicta*, the nearest living representative of the well-known "Fairy-Loaves" (*Ananchytes*) of our Chalk strata.

When we come to study the relations of the Tertiary fauna and flora to those now in existence, the lineage becomes so striking, that in many instances it appears to be almost direct. The rule holds good, also, in that we find the relationship to be nearer in proportion as we approach the human epoch. The earlier stages of the Tertiary age are most interesting, on account of the distribution of animals over European latitudes, whose natural home we have been in the habit of supposing far away. The commonest of mammalian species peculiar to this era are the Tapir-like animals first made known to the scientific world by the genius of Cuvier. This group is now limited to such widely severed and isolated areas as parts of South America and the Malayan Archipelago, two species being met with in the former region, and one in the latter. The Tapiroid animals had as cosmopolitan a distribution during the early Tertiary or Eocene period as the Marsupials above mentioned enjoyed during Secondary times. Their present limited areas of occupation are due to the numerous physical changes which have passed over those countries where their bones are found in the fossil condition, so that their geographical isolation is a good index to what has taken place in this respect since the Tapir family was domiciled in Europe. It is more than probable that, since then, the two great continents of India and America have been disjoined. The high grounds of this submerged area are still occupied by the Pacific islands and coral reefs; the very existence of the latter being, according to Darwin, sufficient evidence that the depression is still going on. Even such apparently insignificant animals as land snails have been subjected to the same geographical changes as larger and more important groups. A common snail in the United States (*Helix labyrinthica*) is found abundantly in the fossil state in certain Eocene beds in Hampshire, a sure proof of its having once lived in that country as it is now living in America; and an equally eloquent testimony to the physical changes which have narrowed its distribution to its present localities. The fossil plants of the early Tertiary epochs speak to the same effect as the fossil animals. Unger has shown that the Eocene beds of Europe contain 173 species closely analogous to forms now growing so far away as New Holland and the Southern Hemisphere generally; another illustration that widely dissevered localities of existing species are good evidence of their antiquity. If the latter rule be good, the philosophical student would apply it to every case, whether of animals or plants, even though their remains had not been met with in the fossil condition. As Darwin has shown, the fossil evidence is extremely fragmentary, nor would the most sanguine of geologists expect the whole fauna and flora of every geological period to be perfectly preserved in the rocks, seeing that the preservation of the forms he meets with is due wholly to accidental causes. A glance at such books as Loudon's *Hortus Britannicus* shows that certain genera include species whose geographical localities are as far asunder in distance as they possibly can be. In our opinion, such cases speak very plainly of their antiquity. A short time ago it was imagined that true woody trees (except the *Coniferæ*), did not appear before the Tertiary epoch, when they were regarded as fit associates for the great number of new forms of mammalia then introduced. But the discovery of such well-known forms as the Oak, Fig, Myrtle, Walnut, Dryandra, etc., in the upper Cretaceous deposits of Aix-la-Chapelle and the Western States of America has shown how great is the antiquity of these now almost cosmopolitan genera. We cannot now do more than glance at the tropical character of the early Tertiary fauna and flora. If we could lay one land-surface over another—the condition in which the Irishman affirmed his rightful inheritance to be—and place a slice of Borneo or Sumatra so as to overlie merrie England, we should have as near an approximation to Eocene conditions in this country as we could imagine!

The middle period in the Tertiary epoch—that commonly known to geologists as the Miocene—bears out our argument still further. Here it is that we first meet with our most abundant evidence of the *direct* ancestry of our living species of animals and plants, which since then have been distributed over the entire surface of the earth. Of all the fossils of this important period, the vegetable organisms are most complete, and it is from them that we derive our most important and correct generalisations. First of all, they point to a much warmer climate—supposed by Professor Heer as sixteen degrees higher than the present—existing over Europe. This temperature, however, was not so high as during the previous Eocene period, as is very evident when we compare the fossil floras of the two eras. Beds of lignite, of Miocene age, rich in fossil plants, are met with in Switzerland, Germany, Scotland, Ireland, Devonshire, Iceland, Greenland, Spitzbergen, and, during the recent Arctic Expedition, within the Polar Circle. The high northern character of the last-mentioned localities shows us that when these plants grew there, in consequence of the mean elevation of temperature, it is probable that *no ice-cap* existed at the North Pole, to the extreme of which this gorgeous flora may have extended. For it must be recollected that these fossil plants afford every evidence of their having grown on or near the spots where they are now found, and that they were not floated or drifted thither. We find the petals, stamens, pistils, and even the *pollen* of some of the Miocene flowers preserved. Many of the leaves have their backs covered with fossil fungi, which affected them then as they attack their representatives at the present day! This alone is strong evidence that the flora is indigenous.

When we come to analyse what may be termed the Geographical character of this Miocene flora—no matter what part of Europe may be selected for the purpose—we are at once struck with its peculiarities. It is not a *European* flora so much as one now more or less distributed all over the globe. The percentages of the fossil plants enable us even to point out the routes which the vegetable migrations subsequently took, whilst geological processes explain the means by which they became limited to the regions they now occupy. The large number of species we have to deduce from almost wholly precludes the possibility of a mistake. Thus in Switzerland alone the Miocene beds have yielded upwards of 800 species of true flower-bearing, or *phænogamous* plants alone, besides mosses, ferns, etc. The total number of fossil plants catalogued from these beds, cryptogamous as well as phænogamous, is upwards of 3000. It is the latter on which most reliance can be placed for the purposes we seek, and we shall therefore leave the former more or less out of our calculations. Among this large number of flower-bearing plants, 327 species, or nearly one half, were evergreens. Since this gorgeous flora was decidedly European, it has become more or less cosmopolitan, and been scattered by geological agencies over nearly all the world. The majority of the species have migrated to America; next we find genera that remained European. Afterwards, in the order in which they are represented in the fossil state, we find other species which have been transferred to Asia, Africa, and even to Australia. The American types are in the largest proportion. This is the most persistent feature of the Miocene flora wherever we study it in the Old World. Their analogues now grow in the forests of Virginia, North and South Carolina, and Florida. They include such familiar examples as Magnolias, Tulip-trees, Evergreen Oaks, Maples, Plane-trees, Robinias, Sequoias, etc. *Sequoias* were European trees even in the Cretaceous period. The higher climature of the mid-Tertiary period is further corroborated by the testimony of the fossil plants now growing elsewhere than in America. Professor Oliver, who so skilfully laid down the relations of the Miocene flora to existing forms in the *Natural History Review* for 1864, has there shown that we must seek for the European species of the Miocene beds by the shores of the Mediterranean; and the Asiatic types in the Caucasus and Asia Minor generally. Camphor-trees, now such very characteristic objects in Japanese scenery, abound in the fossil state in the strata even as far north as Iceland, Greenland, and Spitzbergen!

The only deposits of the age we are now considering to be found in England are at Bovey Tracy, in Devonshire, where the Lignite, or "Brown coal" as it is also called, is worked for the purpose of baking coarse pottery. In this very limited area, fifty species of fossil plants have been met with, twenty of which are common to the above-named Swiss deposits. These fifty species include Evergreen Oaks, Fig-trees, Vines, Laurels, Dryandras, etc.

In the isle of Mull we meet with strata of the same age, and again at Antrim, in Ireland; but their floral yield has hitherto been small. In fact, these beds are mainly interesting on account of their possessing evidence of the last active volcanoes in the British Isles. The Greenland beds have yielded several hundred species to the zeal of Mr. Whymper, and the general teaching is pretty much the same as those of Switzerland, allowing for difference in latitude.

The fossil Miocene flora of Iceland numbers 426 species of true flower-bearing plants, exclusive of others. Amongst this great number are such woody types as the Birch, Willow, Juniper, Rose, Oak, Maple, Plane-trees, Vines, Walnuts, etc., all of them now characteristic of genial temperature conditions. The geology of the Aleutian Islands—which more or less link on the Old World with the New—indicates a connection of these two great continents during the Miocene. All of them possess fresh-water deposits, remarkable for their containing rich stores of fossil plants, marked by the same geographical peculiarities we have already noticed as characteristic of those in Switzerland and elsewhere. Here we have proof that when the Old World and the New were joined by a continuous tract of land, now more or less occupied by the sea, that land was clothed, owing to the mild temperature, with a rich and varied flora. As if to supplement the teachings of the Swiss lignite beds, as yielded up to a careful study of the plants, the *insects* found associated with them are marked by similar geographical peculiarities, and include genera now as widely scattered as the flora. The Œningen beds have yielded over 900 species of fossil insects, whilst the entire number which has been obtained from all the beds of the upper and lower Miocene formations of Switzerland amount to more than 1300! Among them we find the white ants (*Termites*), now so peculiar to sub-tropical regions, as well as dragonflies of the South African, and not European type. The Miocene strata of Austria have yielded fossil butterflies almost, if not quite, identical with Indian species.

These facts point to the conclusion, that the reason why the Southern States of North America are now occupied by a flora which was *European* during the Miocene age, is that such flora migrated thither by way of that continuous land whose geographical, as well as geological, outliers are to be found in Japan, Kamschatka, the Aleutian Islands, Vancouver's Island, etc. This generalisation is borne out by a study of existing plants in some of the localities mentioned. The most significant of the facts is, that the farther we go *east* in the Old World, the more numerous relatively do we find living species which occur fossilised in the Swiss lignites. The *Salisburia*—recently introduced into this country for its singularly graceful foliage—is now limited to the Japanese regions, although it occurs in the fossil state in North America. And there is reason to believe that we have in the *Trigonocarpum* of our English Coal Measures, the fruit of a species of *Salisburia*, to which indeed *Flabellaria* may belong. There are more than three hundred existing species of plants common to the southern portion of the United States and Japan than to Europe. So that in this respect Japan is more nearly related to the New World than it is to that of which it forms an easterly prolongation. Perhaps this terrestrial connection dates back as far as the Carboniferous period. The northerly plants common to Europe, Asia, and North America, are all found growing on the Aleutian Islands, which, as before remarked, stretch across the North Pacific. It seems almost incredible to suppose that a continent has been broken up since comparatively recent times; but other changes, of quite as great geographical importance, have also transpired in the interval, of which the probable elevation of the Alpine chain of mountains, as well as the Andes, are not among the least significant.

It may be asked how it is that the flora which indicates a former land-connection between Asia and America is now principally confined to the southern states of the latter country. In answer we beg to point out that it may have been the gradual incoming of the great northern winter, geologically known as the "Glacial Epoch," which drove what previously had been northern and temperate animals and plants into more southerly latitudes. The Pliocene period succeeded the Miocene, and the organic remains peculiar to it are plainly marked by evidences of a gradual refrigeration of climature throughout the whole Northern Hemisphere. That the plants now living in such areas as South Carolina once had a more northerly extension, is proved by those very species being found fossil in strata of the Pliocene age in Tennessee and elsewhere. This fact not only indicates the way in which such a flora spread southerly, but connects living with Miocene species, and thus clearly establishes lineage.

A glance at the more ancient species of animal life, from the mid-Tertiary period upwards, is full of interest, on account of its supplementing what has been clearly pointed out by a careful comparison of vegetable organic remains. We have already noticed the singular agreement between the Swiss Miocene flora and its entomology, as regards their geographical character. Let us next notice the proofs that the same cause which drove the flora southerly, and isolated it in its present localities—the cold of the Glacial period—operated equally on the animal kingdom, so that its geographical distribution may, in a great measure, be assigned to the same cause. In the Miocene beds of the Sewalik Hills we have numerous evidences of geographical conditions which have since then been wonderfully disturbed, and of animals living in India which have subsequently been distributed elsewhere. The Giraffe and Rhinoceros were then Indian, although they are now confined to Africa. Did space permit, other peculiarities might be mentioned of a similar nature. During the same period the Monkey was a European animal, particularly abundant in the South of France and Greece; and it is more than probable that the last survivor of this group is represented by the rare, protected species which inhabits the Rock of Gibraltar. The well-known "Crags" of Norfolk and Suffolk represent the Pliocene period in Great Britain. Among the hundreds of species of fossil shells they include, are forms now living in the West Indian, Indian, and Japanese Seas, and in the Pacific Ocean. Nothing could more plainly illustrate the gradual increment of cold than a comparative study of the southern and northern species of shells found in these three "Crags." At the same time, their elephantine, rhinocerine, and hippopotamus remains indicate how abundant these animals were in England up to the commencement of the *Glacial* epoch.

CHAPTER XIII.

THE GEOLOGICAL DISPERSION OF ANIMALS AND PLANTS (*continued*).

THE Ice-cap, which evidently began to form at the North Pole during the earlier part of the Pliocene period, gradually increased its area, and crept farther south on all sides. Between the latest "Crag" deposit and the "Drift" beds—the latter of which were formed under undoubted arctic conditions—we have a sequence of an almost unbroken kind, which illustrates, by the increased percentage of northern shells, how the cold was intensifying in this country. At length a rigid arctic climate extended to mid-Europe. Arctic species of animals and plants accompanied the physical ice-invasion, until, eventually, Europe was peopled by them in the Old World, and Canada, Newfoundland, and the United States of America, in the New. The climature can be geologically proved to have grown colder in the latter country, as we know it to have been the case in this. There still exist, in both areas, certain animals and plants which plainly tell of a former continued land-connection. These as lucidly point out the era of this land being broken up, as occurring just before the Glacial period began, or during its progress. The common Pike still lives in American as well as in English rivers; the common Heather is found scantily blooming on the hills to the north of Boston, and many other northern plants are common to the two countries. Scarcely any difference can be detected between the American and European Beavers, although the longer period of civilisation in the Old World has encroached on their haunts, and thus rendered them almost extinct.

The physical and geographical changes which took place during this great Northern Winter were of a most extensive nature. We have ample evidence that Great Britain was eventually submerged, as far south as the Thames, to the depth of at least fifteen hundred feet! Over the greater part of this tract were strewn the thick beds of sand, gravel, and clay, termed by geologists the "Northern Drift." Arctic mollusca then lived in British seas in Arctic proportions. Icebergs from the north, laden with "erratic" boulders, gravel, etc., stranded in the shallower waters, and thus introduced northern plants into Britain and Europe. The subsequent upheaval of the country, until dry land appeared, was doubtless quite as slow a physical process as that of submergence. In the south of Europe we have proofs of even greater physical disturbances than those which once more made Britain into a sea-bottom. Whilst the "drift" beds were forming in this country, limestone beds were being laid down over what is now Sicily, and these were afterwards upheaved to three thousand feet above the sea-level. A great portion of North Africa was then under water, the latter occupying the present desert of Sahara. Here it was that the burning sands were originally accumulated. British mollusca, such as the common oyster, cockle, etc., had migrated southerly, driven thither by the encroaching cold, and had taken up their positions in Sicilian and African seas, just as the Arctic species had occupied the English area. Hence they are found fossil, both in the Sicilian limestones and beneath the drifting sands of the African deserts. Canon Tristram discovered a species of fish in a salt lake more than three hundred miles inland, which has since been found identical with a species living in the Gulf of Guinea. Most of the species of Rhinoceri, Hippopotami, Elephants, Hyæna, etc., passed over to Africa and Asia during the dry land connection, where their descendants still exist. Only those animals remained behind which could adapt themselves to the changed conditions. These appeared on the dry land, and spread themselves over that portion which was uplifted towards the close of the Glacial epoch. As the woolly-haired mammoth (*Elephas primigenius*) and woolly-haired rhinoceros, their remains are met with in post-glacial deposits ; whilst in Northern Asia their tusks have accumulated to such a degree, and been so well preserved, as to form the "Ivory Mines" of Siberia! In the deeper and colder portions of the British seas there still exist, as Professor Edward Forbes pointed out, a few species of mollusca which came over during the great Arctic invasion, and, having retained suitable habitats after the warmer conditions ensued, remained behind to add the mite of their testimony to the general mass of evidence. Perhaps one of the best illustrations of this influence of the former Arctic climature upon the geographical distribution of animals, is that given by Mr. Andrew Murray, in his elaborate work on the *Geographical Distribution of Mammals*. Two species of seal are now living, one in the Caspian Sea and the other in Lake Baikal. As is well known, the latter is situated almost in the centre of the great Asiatic continent. As its name implies, it is completely isolated from any other body of water, as is also the case with the Caspian. Baikal is purely a freshwater lake, whilst the

Caspian has only one-third the ordinary saline properties of sea-water. The seals found living in these two great lakes belong, one of them to the same species as that still frequenting the northern shores of Britain, and the other to a species exceedingly abundant in the North Atlantic. A depression of five hundred feet would once more bring the chilly waters of the Arctic Sea over the area of the Caspian. And we have seen that, during the Glacial period, Britain was submerged to more than three times that depth. We therefore agree with Mr. Murray that the only way we can account for the presence of these seals in isolated bodies of fresh and nearly fresh water, is by supposing that when Northern Asia was uplifted from the bottom of the glacial sea, the two lowest hollows remained filled with water, in which the seals were shut off from their oceanic fellows. Their habits were subsequently altered, gradually, to suit their new conditions, and these, it would seem, were attended with certain varietal differences which distinguish them from their marine brethren. That they flourish under such apparently anomalous circumstances is evident by the fact that seal fisheries are profitably conducted both in Lake Baikal and the Caspian Sea. Other large freshwater lakes yield zoological evidence of their having once been occupied by the sea. Thus in Sweden there are certain lakes in which we find ordinary marine crustaceans living.

Seals, also, are common in the great inland fresh-water lakes of Newfoundland.

Important though the information furnished by the animal kingdom may be, on the geographical distribution of animals, that afforded by botany is even still more impressive. The geology of the "Drift" beds enables us to understand how it was possible for Arctic plants to pass from Arctic regions, so as to occupy the summits of even Equatorial mountains. Dr. Croll, from astronomical deductions, fixes the date of the Glacial period at two hundred and forty thousand years ago, and estimates its duration at one hundred and sixty thousand years. There is, however, good reason for believing that the Glacial epoch, which was not the first our Northern Hemisphere had experienced, was mainly due to the changes which occur in the eccentricity of the earth's orbit. When the eccentricity is greatest, a great alteration is produced in the climature of the Northern and Southern Hemispheres alternately. One enjoys a long period of warmth, and the other suffers from protracted and rigorous cold. An enormous amount of physical change could be wrought in the period assigned by Croll, especially as the rigorous climature, and the encroachment of the northern ice-cap over the available area of occupation, would crowd species more together, and thus render the "struggle for existence" all the keener. It is estimated that the northern shores of the Baltic are being elevated at the rate of about three feet in a century. In one hundred thousand years this would elevate them as high as we know the Sicilian beds have been upheaved since the commencement of the Glacial epoch.

It was after the emergence of Northern Europe and Asia from this Arctic sea, that other floral migrations began to spread over the newly made dry land. The climate was still rigorous in its character, the snow-line coming down in the winter much nearer to the sea-level. Over the available area, Arctic plants spread themselves, finding luxuriant habitats in the newly-formed subsoils of the "drift." The hairy mammoth, woolly-haired rhinoceros, the Irish elk, the musk-ox, reindeer, glutton, lemming, etc., more or less accompanied this flora, and their remains are found in the post-glacial deposits of Europe, nearly as low down as the south of France. In the New World, beds of the same age contain similar remains, indicating, that they came from a common northern centre, and were spread over both continents alike.

When the animals and plants of the *Arctic* and *sub-Arctic* regions of the Old and New Worlds are compared, one cannot but be surprised at their identity. All, or nearly all, belong to the same genera, whilst many of the species are common to the two continents. This is most important in its bearing on our theory, as indicating that they radiated from a common centre after the Glacial period. When we explore the *Temperate* regions of the same countries we find the floral and faunal differences increasing, as one would expect in remembering that many of the species may even date from the Miocene epoch. In *Equatorial* latitudes this contrast reaches its climax. We know of no general theory that will explain this peculiarity except that Arctic and sub-Arctic species have spread *since* the Glacial epoch; whereas the southern and equatorial forms are older geographically, and were driven to their present areas of occupation by the slowly, but surely, advancing cold of the period in question.

The flora characteristic of Britain is marked by being opposed to extreme cold on the one hand, and intense heat on the other. It is a flora, therefore, which could only have possessed the plains of England after the rigidity of the long-continued glacial cold had given way to warmer conditions. In fact, it is a recent introduction, and there can be little doubt that its original home was Asia Minor. Most of our common English plants are now equally as common in Japan. Our familiar flora seems to have originated in almost the same centre as Man himself. Possibly much of it may have accompanied his wanderings, as we know it does attend the footsteps of the modern English emigrant. Any one looking over Dr. Hooker's *Student's Flora of the British Islands* cannot but be surprised to see how geological barriers more or less coincide with the geographical distribution of our commonest British plants. Of these barriers the great Sahara is one, and the northern flanks of the Himalayas another. We have seen that the former was sea during the Glacial period, which, of course, would forbid the northern migration of African species of plants. After its elevation, the burning sands of the desert formed a barrier quite as effective as a sea. Hence, as Mr. Andrew Murray has remarked, for all practical purposes in zoology and botany we may regard that part of Africa, north of the Sahara, as a portion of Europe situated in Africa. It has a preponderance of European animals and plants, and was doubtless connected with Europe, by way of Gibraltar, before it was with Southern Africa.

The common flora we have spoken of as now occupying "merrie" England is botanically known as "Celtic." But, besides this, we have in this country an admixture of other floras, whilst the continent of Europe is marked by a blended association even more strongly. In this respect, their occupation is not unlike the mixture of Latin and Teutonic races of mankind, brought about by the successive disturbances and invasions during the earlier stages of European history. For example, in the Pyrenees we have several species of plants still growing which must have had a continuous European descent from Miocene times. They have been adapted to the physical changes meantime at the expense, perhaps, of specific alteration.

The *Ramondia* and *Dioscorea* really belong to

Japan and China, and, as M. Martins has observed, to find them growing on the Pyrenees is as striking as if we found a family of Chinese or Japanese people living in the same regions.

The Dwarf Palm (*Chamærops humilis*), the only species of its kind growing in Europe, is an inhabitant of Southern Europe, and reminds us of pre-Glacial circumstances as much as the occurrence of the only species of European monkey on Gibraltar reminds us of the former extension of its race during Miocene times, of which it is now the single outlier.

It could hardly be expected, especially from an evolutionist point of view, that plants whose species have a long ancestry would grow in any great abundance over areas which have been subjected to successive geological changes. We have already spoken of an arctic flora having first occupied the newly-emerged lands of the "Drift" in Britain; we now return to the subject for more detailed examination. When the warmer changes ensued which resulted in the present climature, the difference rendered the Arctic flora unable to compete with the incoming Asiatic plants to which those changes were so favourable. Accordingly the former ceded the ground, the only places remaining open to them being the cold sides and summits of the higher mountains, where they would not be likely to be expelled by the newly-introduced lowland and warmth-losing flora. Hence it is that we still find undoubtedly

Arctic plants now growing on the margins of European glaciers, or on the tops of our English, Welsh, Irish, and Scotch mountains. On the Faulhorn, in the Canton of Berne, at nine thousand feet above the sea-level, there grew one hundred and thirty-two species of flowering plants, of which fifty-one are common to Lapland, and eleven to Spitzbergen. In the Engadine, a high valley in the Canton des Grisons, there are found eighty species of plants unknown to the rest of Switzerland, but very common in the extreme north of Europe. Taking the alpine flora of Switzerland as a whole, we discover that out of a total number of three hundred and sixty species, one hundred and fifty-eight are common to Scandinavia and northern Europe generally. The relation of the European alpine flora to that of the Arctic Regions may also be attained by reversing this comparison. Thus, out of six hundred and eighty-five flower-bearing plants found in Lapland, one hundred and eight are also met with on the Swiss Alps. This extension of the Arctic flora during the Glacial period is proved in a similar way in the Pyrenees, where we meet with sixty-eight species of plants which are common to Scandinavia. Thus do the very anomalies in natural history assist in the process of their own explanation.

Having rapidly glanced at the immediate influence of the later geological phenomena upon existing zoology and botany, let us next inquire whether the various physical disturbances have been such as to enable us to investigate geographical distribution by the aid of certain general principles. This is not altogether impossible. For example, we may lay it down as a good rule, that islands which are separated from adjoining continents by shallow seas, have been insulated within a much more modern period than those separated by deep seas. We find that the flora and fauna of islands are related to those of the mainland in proportion to the depth of the intervening waters. Great Britain herself is a good illustration of the principle. She has no fauna peculiar to herself, except the well-known Red Grouse, and only one plant, a species of orchid (*Spiranthes gemmipara*). All the rest are the same as we find on the Continent. Our land and freshwater shells, freshwater fish, etc., are identical with continental species, and as these could not have crossed the salt sea, it is evident they must have spread over England before she was severed from the European mainland.

Deep seas are always indicative of longer periods of time to effect the depression, so that, if an island had been separated from Europe in Miocene times, its fauna and flora would still possess more or less of a Miocene facies. Such is the case with Madeira, the Azores, etc.; they were formed as volcanic islands early in the Tertiary period, and peopled by straggling birds, insects, plants, etc., from the adjacent mainland, as Sir C. Lyell clearly showed in the latest edition of his *Principles.* The absence of all mammalia, except bats, proves that this was the process (which Dr. Darwin has clearly explained in his *Origin of Species*) by which such ancient volcanic islands were first stocked. Madeira and the Azores have been considerably upheaved since then, and beds of volcanic ash are found on them, enclosing shells allied to those which lived on the mainland during the Miocene period. The existing land shells are lineal descendants of these. The plants of Madeira are also marked by similar belated features. Mr. A. R. Wallace has clearly shown reasons for believing that Madagascar must have been separated from Africa before the characteristic large animals of that continent had been introduced. Its well-known Lemuroid animals, however, indicate that Madagascar may have been joined to Africa during early Miocene times, when those animals were distributed as far north as Greece and the south of France, in which latter country their remains have been found in the phosphorite deposits.

Somewhere about the time when our Norfolk and Suffolk "Crags" were being laid down, there were extensive geological and zoological changes taking place in other parts of the world besides the Northern Hemisphere. We have evidence of a similar cold epoch in the Southern Hemisphere to that which took place in the Northern, although it does not seem to have been of so extensive a character, or of so long a duration. Whilst it lasted, however, Antarctic plants were driven northerly, just as in the Northern Hemisphere we have seen that Arctic species were subsequently forced southerly by similar agencies. Darwin has shown that Australian plants are still found growing on the summits of the mountains of Borneo and other islands of the Malayan Archipelago. They also extend along the higher parts of the Peninsula of Malacca, and are thinly scattered, on the one hand over the mountainous regions of India, and on the other over similar tracts as far north as Japan. In some of the higher parts of equatorial regions we find Arctic and Antarctic plants in strange community, the former predominating, perhaps, on account of the greater proportion of land in the Northern Hemisphere; but both kinds have been thus brought together from the opposite poles of our planet by similar physical operations! We deduce from this occurrence an oscillation of extreme climates, or Glacial epochs, in the northern and southern halves of the globe alternately. Since the Antarctic Glacial period concluded, the Malayan Archipelago may have been formed by a breaking up of a prolongation of the Indian continent. Previous to this occurrence there had been a similar extension of Australia in the opposite direction, so as to nearly join the former, and this had shared the same geographical fate, as the islands of New

Guinea, etc., plainly show. The community of fauna and flora is such that we cannot be surprised native tradition should assert that Java, Sumatra, Bali, Lombok, etc., were formerly united. The mountains of these islands form a continuous chain. The Asiatic animals and plants terminate at Bali, whilst the Australian types commence at Lombok, thus showing that the tradition is zoologically wrong, if nearly geographically correct. In 1843 Mr. Earle pointed out that Java, Sumatra, and Borneo all stood on a plateau which was covered only by a shallow sea. The map indicates that this plateau is nowhere more than a hundred yards in depth. Mr. Wallace has worked at this zoological problem, and, with his usual keen perception of causation, has clearly shown why the fauna and flora of the Malayan Islands are nearly allied to those of the Indian Peninsula. Dr. Sclater was the first to notice that the dividing line between the Asiatic and Australian fauna must be drawn down the Straits of Macassar, and Mr. Wallace subsequently showed that this line ought to be continued southwards through the Straits of Lombok. Looking at the islands, which seem to act as a series of stepping-stones between India and Australia, it would never be suspected that they could be divided into two such distinct zoological regions. The Elephant, Rhinoceros, and Tapir are found in Borneo, of exactly the same species as those inhabiting India. The animals could not have swum across the neighbouring straits, and therefore must have existed over the area before the extended peninsula had been broken up into islands. When we come to Lombok, we have a distinct group of animals and plants from the former. As Mr. Wallace remarks, although "the strait between this island and Bali is only fifteen miles wide, we may pass, in two hours, from one great division of the earth to another, differing as essentially in their animal life as Europe does from America." Through these straits, it has been shown, there runs a very rapid current, which more or less forbids migration from one group of islands to another. This, however, is not the sole cause of the striking difference in the natural history peculiarities of the two areas. The water in the straits is much deeper than in the great submarine plains which connect the islands of India on the one hand, and those of Australia on the other. The Marsupials, Cockatoos, Bush Turkeys, Lories, etc., of the Australian group, certainly indicate their former connection with the southern mainland. The conclusion arrived at by Mr. Wallace, and accepted by all philosophical naturalists, is, that the difference between the two groups of islands, as regards their zoological and botanical characters, is to be ascribed to the fact that when India extended uninterruptedly to Bali and Australia to Lombok, there was a strait occupied by a deep and rapid current separating them. Hence it is that for ages the two regions have been geographically separated.

South Africa in part may have been dry land since the Secondary age, and have suffered chiefly from ordinary meteorological influences, unless we allow for a probable elevation of the whole area. The great lakes occupy elevated regions, and among their fauna are those ganoid fishes which we believe are "survivals" of the Palæozoic forms. The Cycadaceous plants remind us of Oolitic times, when they were so abundant in what is now Great Britain. The Palestine lakes seem to have been formerly connected with the great freshwater lakes of Southern and Equatorial Africa. Sixteen species of fish occur in the former, of which five species are common to the latter; whilst only one species is common to the rivers which empty themselves into the Mediterranean. This solitary species may have been accidentally brought by some such agency as that of land birds; but we must look to more fundamental and geographical causes to account for so many species common to bodies of fresh water situated at such a distance from each other. The raised beaches of the Dead Sea indicate an upheaval of the area, or the possible shrinking of its brackish waters, probably due to the increasing heat since the gradual waning of the glacial cold. In the earlier stages of the Tertiary age, it is probable that South Africa may have been connected with India, by way of Madagascar, the Mauritius, and other islands. These islands are remarkable for special kinds of plants and animals, as, for instance, the Double Cocoa-nut (*Loidicea Seychellarum*); whilst certain great Land Tortoises, the Dodo, Solitaire, etc., have disappeared from them during historical times. The huge Tortoise is still living on Aldabra, but it is met with only in the recently fossilised condition in the Mauritius.

The Giraffe originated in India, where its remains are found fossilised in the Sewalik deposits before mentioned. It is now extinct in that country, and met with only in Africa. The intimate connection between the Indian and Cape Buffaloes is employed by some naturalists as an argument in favour of the former terrestrial connection between these two great countries. Mr. Murray regarded the distribution of the Antelopes as especially favouring this view. There exist altogether about one hundred and fifty species of Antelopes, of which five-sixths are African. More than two-thirds of the entire number come from districts south of the Sahara, which forms their northern limit, just as we have seen it acts as the southern barrier to the European fauna and flora. Next to Africa, in the representation of Antelopes, comes India. So that it would seem, says Mr. Andrew Murray, as if Africa were the natural home of these creatures, and that they had come into existence there before its severance from India. Another connection between the two continents is the occurrence of the Camel, in the fossil state in India, and in the living condition in Africa. Some naturalists imagine there, is good reason for believing that Africa was not greatly peopled by carnivorous animals before the Glacial epoch, when many of them were driven thither from higher latitudes by the increasing cold.

South America affords another illustration of a land surface which has been such for long-continued geological periods. The huge Mammalia, such as Mylodon, Glyptodon, Toxodon, Megatherium, etc., are nearly all allied to the characteristic groups still living over the same areas. To some of the animals the Andes act as the principal geographical barrier, whence it would appear that this chain of mountains has been elevated since some of these species came into existence. The height at which very recent raised beaches and banks of recent corals have been found on the Andes is proof of their comparatively late upheaval. Nor should the immense height of these mountains forbid the supposition here entertained, as we know for a fact that Etna has been formed since the commencement of the Glacial period. In Lake Titicaca, situated at the height of 12,500 feet above the sea, there are found living eight species of *Allorchestes*, belonging to a truly marine family of Amphipod crustaceans. One species is found here, and again in a lake much lower down, at 3300 feet above the sea. The same species is found living in the sea in the Straits of Magellan. These facts, taken together, as Professor Martin Duncan has shown, necessitate the belief in the former marine condition of that highly-perched piece of water, Lake Titicaca. Of the two species of Tapir found in South America, one roams at some height on the mountains, and is covered with woolly hair (thus reminding us of the special adaptation of the Mammoth) to protect it from the cold moisture; the other species wallows in the tropical rivers which water the forests and plains.

Before the Glacial epoch began, many species of the genus *Equus* or Horse lived in South America. Farther to the north, in the remarkably developed Eocene and Miocene beds of the Western States, Professor Marsh has obtained such a large number of species of fossil Horses as to have completely worked out the evolutional history of this important animal, from its five-toed Eocene ancestor! Hence it cannot be said it was not adapted to the country, as the fossil bones indicate it must have abounded in immense numbers; whilst the manner in which the modern Horse has run wild since its re-introduction by the Spaniards would plainly forbid such an idea. The total extinction of the American Horses, therefore, must have been the result of local geological or biological operations. Contemporary with the native species of American Horses there lived other forms which we are equally in the habit of regarding as peculiar to the Old World, such as the Elephant, Mastodon, Rhinoceros, etc., whose remains occur in the fossil state in deposits of the same age as those in Europe. Indeed, the Mastodon would seem to have existed in America long after its extinction in this country. When driven southerly by the encroaching cold of the Glacial period, these animals were perhaps unable to cope with the huge arboreal mammalia whose long-continued possession had so suited them to the conditions of existence. The occurrence of the remains of the Camel, in the fossil state in India, and of other species now living in Africa, and even South America, is a strong proof of the great antiquity of this genus. Indeed, next to the Marsupials and Tapirs, the Camel is one of the oldest of living genera. We meet with it first in the early Miocene formations at the foot of the Himalayas. Then in the Pliocene period, a larger species (*Merycotherium*) roamed over Siberia and the easternmost boundaries of Asia, possibly crossing over to America by way of the then continuous land-connection of which the Aleutian Islands are now the only relics. We next meet with two fossil species in Kansas, and of several others which evidently ranged over the greater part of the United States. Several fossil genera are peculiar to South America—the only part of the New World where the Camel family now exists, as the Alpaca and Llama testify.

But perhaps the best proof of the immense ages that South America has been dry land is afforded by the peculiarities of its living fauna and flora. This is what Mr. Bates, in his *Naturalist on the*

Amazons, has appropriately termed *arboreal*, that is, adapted almost to a forest existence. Of all the countries in the world, Central America is perhaps the most densely wooded, and it seems to have been so for ages. Its Monkeys are distinguished from those of the Old World, not only by the greater breadth between the nostrils, but more especially by their prehensile tails, which act the part of a fifth hand, and enable their owners to suspend themselves bodily from the boughs of trees whenever necessary. The Sloths, Opossums, Ant-eaters, and Porcupines, are all arboreal ; the last three, if not the first, also possessing prehensile tails like the monkeys, and for a similar purpose. In addition to these, we have only to name the Green Pigeons, Toucans, Tree-beetles, Bird-catching Spiders, etc., to perceive the extent to which this arboreal adaptation is carried. The flora is equally strong in similar testimony. A great number of the genera are parasitic, either vitally or mechanically, and grow to such a prodigality as frequently to strangle the great trees to which they attach themselves. That a similar forest character distinguished this part of America in Tertiary times, is evident from the remains of the gigantic Sloths, or Megatheria, which pulled down the trees to browse upon them, instead of climbing them like their modern representatives. The tributary valleys of the Amazons have each a distinct flora. Hence the long-continued arid surface of South Africa is testified to by the Antelopes on the one hand, and on the other, in the same latitudes in America, there is equally strong proof of an extended forest life.

We have endeavoured to glance at this important subject by the aid of such philosophical generalisations as have been supplied by still living naturalists, among whom Mr. A. R. Wallace stands foremost. His *Geographical Distribution of Animals* is one of the intellectual monuments of the age in which we live. A great deal of information on this subject still requires collection and comparison. It is scattered through the scientific memoirs of most European Societies, and completely hidden away, not only from the general reader, but in a great measure from the scientific world as well.

Only a thorough knowledge of Tertiary palæontology and physical geology can explain the anomalies of the distribution of existing animals and plants. We have several times referred to the existence of "natural barriers" to species, indicating that such barriers were related to the spread, or otherwise, of species. When these have been the result of geological operations, the natural history groups are found to be more or less coincident with them. To Dr. Sclater belongs the chief merit of mapping out the distribution of modern faunas and floras, although Edward Forbes, in his masterly essay on the *Relation of the Pliocene Fauna and*

Flora to those of Modern Times, was the first to indicate the direct lineage of existing species. The history of geographical botany and zoology only commenced in 1857, when Dr. Sclater sketched out his six principal regions for the distribution of birds. It might be imagined that creatures like these, gifted with the power of speedily changing their habits, would be far more irregularly spread than plants, or even animals. But it has been found that, with some slight modifications, the same mapped-out provinces would include the general distribution of quadrupeds, reptiles, insects, land-shells, and to a certain extent, even plants. These six regions, now universally adopted by naturalists, are the following:—1. The Neo-Tropical, comprising South America, Mexico, and the West Indies. 2. The Neo-Arctic, including the rest of America. 3. The Palæ-Arctic, comprehending Northern Asia as far as Japan, and Africa north of the Sahara. 4. The Ethiopian, containing the rest of Africa and Madagascar. 5. The Oriental, comprising Southern Asia and the western half of the Malayan Archipelago. 6. The Australian, which includes the eastern half of the Malayan Archipelago, Australia, and most of the Pacific islands. The great geological changes of the Tertiary era group more or less round these six centres.

Hasty though our glance at the dispersal of the great families of animals and plants has been, we hope we have been able to indicate the unity which springs out of comparative diversity. Thus studied, in the dim light of the past as well as in the more effectual illumination of the present, otherwise disjointed and broken facts start together like the "dry bones" in the prophetic vision, and become animated with the Life which has filled the terrestrial creation from its earliest dawn until now.

CHAPTER XIV.

WATERY WASTES.

GREAT and general as are the geological changes which have been rung upon its surface, at various periods of the earth's history, there appears to be no law in physical geography more persistent than that which bids "the waters to be gathered into one place," so that the "dry land may appear." Nearly three-fourths of our planet's surface is covered by water, chiefly, of course, as seas and oceans. On the remainder—a little more than one quarter of the entire area, and much of that inaccessible as mountains, or bound in realms of eternal ice—poor humanity is nursed as in a terrestrial cradle. This limited space is the graveyard not only of our own race, but of every species of animal and plant, terrestrial or marine, which has come into being since first the waters began to bring forth abundantly. It is a space contended for by untold millions of living creatures besides men. The rocks over which the soils are strewn, and whose produce feeds this various creation, are themselves huge sepulchres "written within and without" of the life that has been. Even with regard to our earth as a planet, the modern doctrine of Evolution indicates there is a Plan and a Purpose silently but surely being worked out during the slowly rolling ages!

It is the fact that as a rule the water is separated from the land which enables terrestrial life to exist so abundantly; wherever we have a "Serbonian bog" kind of mixture, there do we find that both animals and plants are few and undiversified. But the operations of physical geography are like the delicate mechanism of a well-constructed and highly sensitive watch. The slightest variation of the "regulator" causes it to run either too fast or too slow. So is it with the terrestrial portion of the earth's surface. The immense vapours lifted by solar heat from the surface of its vast waste of waters are carried by the winds and drifted against mountain sides or hill summits. There they condense into rain, trickle down as mountain torrents, run together as rills and rivulets, join each other and form rivers, and anon they find themselves once again part of the huge volume of oceanic waters whence they were originally raised. Like the diurnal rotations of the earth on its axis, which go on through a practical eternity of time, all things earthly revolve in cycles. The process just described has been going on after the same invariable order ever since the dry land first began to appear.

Notwithstanding the general law that the water and the land shall remain separated, the boundaries of the two are liable to a constant change. As a rule, it is the former which attacks the latter. Agencies far removed may bring about an unsettlement of the mutual relationship, although there can be little doubt that Man is a great interfering agent. His power for good and evil are made manifest in the natural as well as in the moral world. As the area of dry land is only as one to three of that of water, it follows that the latter is always in a state representing an invader, and the former that of defender. The fairest lands may be inundated and temporarily destroyed. Even in the last two or three years of celebrated "floods," we have had evidence in England alone of the devastative power of water. Those terrible results of the bursting of the Holmfirth Reservoir in 1851, and of that at Sheffield in 1864, only too vividly impressed upon people's minds the destructive forces held in check wherever there are water-works. "Fire and water," says an old proverb, are "good servants, but bad masters!" Notwithstanding the wonderful manner in which the physical geography of the greater part of Europe has been subdued by man, his conquest has not been effectual. Every year news comes to us of the chief rivers overflowing their banks, and laying waste much of the fertile lands they traverse. It would almost seem as if the waters were now poured down European rivers more violently than formerly. The question we have to ask is, whether man can really affect the arterial drainage of the country he inhabits? In many respects, this will be held to be a most important subject for discussion. Apart from the actual destruction of property which takes place, we must not forget the actual physical and mental suffering which ensues. Those who visited Lincoln in the early part of 1877, and saw the low-lying and poor parts of the town so inundated that boats plied up the narrow and unsightly streets, and relieved the terrified and agonised inhabitants who had taken refuge in the upper rooms, will readily grant that, much as we have subordinated the forces of nature, we have not yet conquered them. At intervals of a few years we hear of floods in the south of France, especially in the neighbourhood of Toulouse, when scores of people are killed, cattle destroyed, property annihilated, and the hard earnings of a thrifty people vanish like vapour in a single night! Can nothing be done to stay this kind of thing? Are we to be year after year the victims of physical geographical circumstances of this kind? If the waters are not sufficiently separated from the dry land, whose fault is it that the Divine fiat is not strictly carried out?

This brings us to note a few of the great floods which have become historical through the great destruction both of life and property which took place through their agency. It is to be doubted, however, whether the insignificant occurrences every winter and spring are not, in the long run, more devastatory. Almost every country watered by large rivers has a fluvial history of catastrophes associated with them. As the magnitude of every river is dependent upon the area of the catchment basin, and the varying amount of rainfall, it follows that the magnitude of river-overflows or inundations is usually proportionate to the size of the rivers themselves. Every year there are immense inundations in the valley of the Amazons, and in the valleys of its tributary rivers. The latter are regarded as part of the Amazon river-system, and a peculiar fauna and flora are more or less adapted to these conditions. The floods of our Indian rivers are commensurate with the magnitude of the streams, those of the Ganges being almost annual in their occurrence. The overflows of the Nile are historical, and occur as regularly as the return of summer. Such inundations can hardly be called cataclysmal. In the case of the Nile, the fertility of Egypt depends upon it; and an ancient system of agriculture has sprung up in that country thoroughly adapted to the physical effects produced annually by the Nile floods. As these inundations always occur where the land is lying lowest, and as the waters cover the low-lying land when they are discoloured with the muddy matters brought down by the rains from the higher grounds, it follows that in course of time such inundations create their own natural checks. Every year a thin layer of alluvium soil is strewn over the areas occupied by the inundations, and thus the swampy land is eventually raised high enough to confine the swollen waters of the rivers to their natural channels. It was an ancient saying that "Egypt was the gift of the Nile," and geological investigation proves that the annually added loams brought down by that river are some hundreds of feet in thickness. In every river valley we have peculiar black soils known as *alluvium*, and these are known to be the accumulated sediments brought down in the course of ages by the adjacent rivers.

Rivers, therefore, may be recuperatory in their action, as well as destructive. But it is astonishing what even drops of rain-water can do when combined. Sir Charles Lyell mentions that when he was travelling in Georgia and Alabama, in 1846, he saw hundreds of valleys commenced where the ancient forests had been cut or burnt down. There can be little doubt there is a distinct connection between the rainfall and mean temperature of a country, and the number of trees the latter may possess. Trees are magnificent regulators of climature. They are to it what the pair of revolving "governor-balls" are to a stationary engine. When the engine is going too fast, the "governor-balls" distend, and "throttle" or compress the aperture whence the motive steam power is issuing. When the engine is working slowly, the balls droop, and so open the valve as to allow more steam to issue. The same with the woods and forests of a country. When the rainy seasons are on, every tree and plant absorbs some of the moisture, and stores it away in its own tissues. It thus prevents great quantities from flowing off the surface, and gathering into rills and rivulets, and so swelling the main rivers as to cause them to overflow their lowest lying banks. During periods of drought, the leaves of the same forest give out the moisture they consumed into the atmosphere, and so prevent its being as dry and parching as it otherwise would have been. During the hours of night, also, the surfaces of the leaves become colder than the air, and thus the moisture contained in the latter is condensed upon them as dews. In many parts of Arabia this is the only kind of waterfall with which the parched earth is visited.

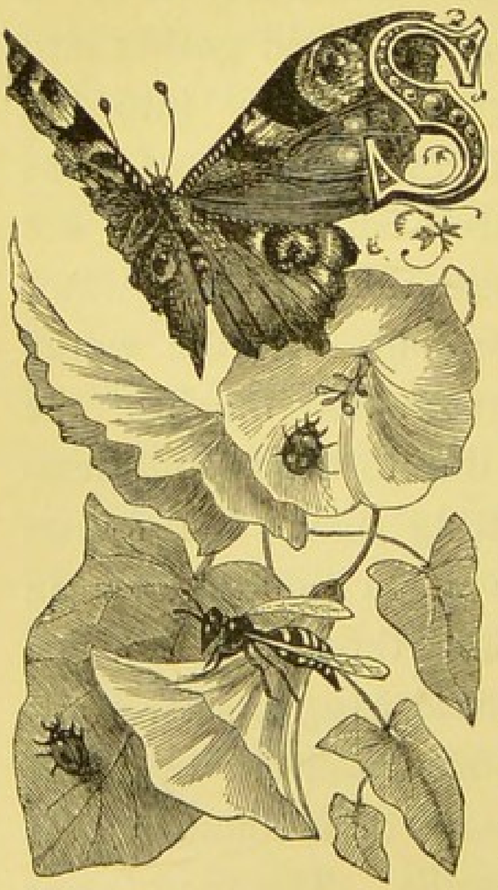
The destruction of woods and forests, therefore, is always attended by an alteration of climate for the worse. It becomes more irregular. There are now alternate periods of rainfall, and consequent floods, and of droughts. No country in the world has been so altered in this respect as the United States, for in no other has there been so much clearing of forest land within the last two centuries. In Italy great destruction of forests has taken place, and the summers are now more arid and hot in consequence. The reader will find in the Hon. G. Marsh's *Physical Geography as influenced by Human Action*, a long list of parallel cases, where men have unconsciously modified the climate of the country in which they dwelt. Sometimes this is for the better, as in the case of the Fen districts of Cambridgeshire. These places, which were watery wastes during the times of the early Norman kings, are now well drained ; and rich crops smile and wave where once unbounded sheets of water stretched from horizon to horizon, only varied by islands of water reeds. The temperature of the Fen country is ten degrees higher than it was when undrained. The same fact is characteristic of the neighbourhood of Bolton, in Lancashire. The bogs and moors are drained and under cultivation, and the heat of the sun, once expended in lifting the waters from the surface by evaporation, is more usefully exercised in warming the land, and in thus promoting the growth of corn. Man, therefore, may "be a co-worker with God," even in his influence to modify for the better the climate of his native land! If it be a good thing to cause two blades of grass to grow where only one grew before, we hold that it is equally wise to plant trees where there were none before. Our English towns are often dreadfully unlovely, when they might be rendered bright and cheerful by such "boulevards" as we see in continental towns, as well as in those of North America. There is a tendency for us to recognise this fact, and tree-planting is taking place among us more than it ever has done. Let us thoroughly recognise its importance, in that trees not only beautify our towns, but they decompose carbonic acid, and give out oxygen where that beneficent gas is most needed. Moreover, we have seen that the regularity of the order of climatal changes is much affected by the extent of arboreal growth; so that by planting more trees we may incidentally be the means of decreasing those floods and inundations we have been considering.

How the surface of the ground can be cut up by the heavy rains which take place after extensive forests have been cut down, is well shown in Lyell's *Principles*. In Georgia, where the land was cleared of forest in 1826, the surface was quite level. Cracks began to occur in the ground when the latter was bared of timber. In these the sudden rains washed, so as to widen the walls, and wear them backward, until, in a short space of twenty years, a chasm had been formed nearly sixty feet deep, three hundred yards long, and from seven to sixty yards wide. In the neighbourhood of hills and mountains, in the

Northern Hemisphere at least, the occurrence of extensive peat bogs may arrest the rapid flow of surface rain-water, and thus prevent floods; although the presence of these bogs must make the climate colder. In the north of Ireland we have most extensive peat-bogs, always soaked with water like a sponge. At the base of the Highlands of Scotland, and of the Welsh and Cambrian mountains, we have extensive areas occupied by swamps. The rain-water trickling down the hard and imporous rocks would gather into rapid torrents, and be poured suddenly into the valleys, if it were not for the arresting power of these swamps. As it is, the sources of the rivers are usually from these bogs, where the excess of water is slowly and constantly given out. Nature works in many ways, and we have seen that much of the devastation of floods may be due to the thoughtlessness of man himself, in cutting down the forests which regulate the climate of a country, or in indolently neglecting to plant those trees which Providence has so plainly utilised as agents for good. We say nothing as to the floods produced by interfering with the arterial drainage of a country, as is certainly the case with water-mills. The time is not far distant when Parliamentary action will have to deal with that nuisance in its own peculiar manner.

CHAPTER XV.

SCIENTIFIC PILGRIMS.



SO the reading public are beginning to understand that science need not necessarily be dry nor uninteresting. The generation of taper-headed youths who airily express their conviction that "Darwin's theory is all humbug," has not yet quite died out; but at the meetings of the learned societies at Burlington House may be seen another type of young men, reading papers and figuring in discussion. They have mystical letters behind their names, but they are not otherwise distinguished by marks of eccentricity or insanity. They do not differ in costume or gentlemanly address from well-bred young fellows who have not made science a pursuit. Their hair is not long, nor are their faces thin, or pale, or unenviably studious-looking. Their coats and trousers are not cut in strange fashion. Possibly their hats are larger than the usual run, for they have to roof bigger heads.

In short, science as a hobby does not render young men more snobbish than does horse-racing or billiard-playing. And there is room for a little of the old Norse fighting temper at these learned gatherings. There is a *casus belli* in almost every theory, and the strife is very like that into which men plunge in matters of everyday dispute, although, mayhap, the subject is archebiogenesis or the demi-sarcode nature of the hydroid polypifera.

It is a promising fact that we are growing out of the old cant about science. If it be the "wisdom of God to hide a thing," then is it "the glory of a king to find it out." Still brighter is the promise in that the great questions in which the human intellect is now engaged are taken up by the young. If their ardent spirits fly somewhat too highly at hypotheses, wisdom is long-lived and can wait. The years will tone down the fiery zeal, and sober industry and plodding investigation will follow. Indeed, we are almost unjust even in associating the names of young men of science with far-reaching hypotheses, for the authors of some of the boldest are *savans* who have grown white-headed in the service of science; and our hardest workers in the laboratory and dissecting room, at the microscope and in the field, are under forty years of age.

Once a year numbers of these investigators of natural laws, old and young, assume the habits, if not the garb, of pilgrims, and converge from every part of Great Britain towards the city where the British Association holds its meeting. As the Congress usually occurs in August, during the Parliamentary recess and the university vacations, the event is a holiday as well as a pilgrimage. Nearly two thousand lovers and pursuers of truth—ladies as well as gentlemen—attend this "Parliament of Science." The time is past when the few *savans* who first met in a little room at York and founded this learned body had their efforts partly ridiculed and partly pitied. Nobody dreamt that the little Association would ever attain to its present importance and influence, or imagined that other countries would proudly copy our example and found national unions for the advancement of science upon the British model. No institution, not even the venerable Royal Society, has equal public influence with the British Association. Other learned societies hold their regular meetings in London, but the outside world rarely hears anything about them. Not so the "British." For forty-four years it has not only allied itself with scientific research and investigation, but it has been the nursing mother to some of the most important popular discoveries of the period. It has worked out the theory of the tides, the variations of the magnetic needle, the laws of storms, the succession of life upon the earth, the spectrum analysis of terrestrial as well as celestial bodies, the nature of comets and shooting stars, and the antiquity of man. Its voice has been heard whenever Parliament has demanded scientific authority, or when any of those great national undertakings have been afoot which bind peoples more nearly together than even their kindred languages and identical lines of descent. In the lists of its presidents are the most brilliant names in British science.

The Association has been the training-school of young and ardent investigators, and the means of introducing to the world men and ideas which would perhaps not otherwise have been heard of. Half a dozen other societies and congresses have copied its example and trodden in its footsteps, but no other organisation has secured so great a popularity. In addition to all this, it must be regarded as a gain that at its meetings science gets possession of the newspapers for a whole week.

The hold which the British Association has upon the intelligence of the nation is exhibited in the eagerness with which its visits are sought by our large towns. On about the fourth day of the Congress the general committee assemble to deliberate on the next place but one that shall be visited—for that of the immediately succeeding year has been already decided upon. Deputations from perhaps half a dozen towns, representing the town-councils, local scientific societies, guilds, manufactures, and arts, are ushered in to describe the advantages which their respective localities may present—geological, botanical, mechanical, or otherwise. The competing towns put forward their best spokesmen, and the meeting is often marked by features of strong humour as well as interest. Perhaps the claims of a particular town have been patiently advanced for three or four years in succession, and then sometimes the others will recognise the claim, and withdraw—only, however, to urge their own petition more importunately next year. And when the decision is made a prospective scientific "revival" ensues in the fortunate town, which forthwith proceeds to raise a fund to meet the cost of rooms, and other local expenses, and to prepare its hospitality.

The local newspapers are usually out of pocket by events of this kind, but they bear the sacrifice cheerfully and produce a voluminous history of the event for honour rather than profit. They engage special staffs of reporters from the metropolis, and frequently secure the services of scientific writers. The old weeklies, and bi-weeklies, in the case of the smaller towns, are jerked out of the comfortable groove in which they have been quietly spinning for years, and suddenly find themselves metamorphosed into "dailies" for the first time in their existence.

There are scientific pilgrims who through a long series of years never miss one of these meetings, and who are wont to compare one year's local reception with another and to mark the curious differences. The smaller towns break forth into a blaze of colour, whereas such places as Liverpool and Bradford hardly honour the occasion with half a dozen yards of bunting, life being too earnest and arduous for the hanging out of banners. But everywhere the local public throng the doors of the buildings where the evening lectures and *conversaziones* are held, hoping to catch a glimpse of the owners of great names, whose published opinions or researches may have caused old theories to shake and totter if not to fall. Nowhere have we seen such eager gatherings or witnessed so much intelligent curiosity of this kind as at Exeter, Sheffield, and Bradford. Of late years the committee have thrown a very popular element into the annual gathering of the Association, by telling off one of their best known members to the duty of giving a lecture on some important scientific subject to the working men of the district. The lecture is usually delivered on a Saturday evening in the largest hall in the place, and the room, however large, is always densely crowded, the working men having formed a committee and made arrangements for the discourse weeks beforehand. The attendance of the members of the Association at these lectures is strictly forbidden, in order that the classes for whom they are intended may have accommodation enough. That the lectures are listened to by appreciative audiences we hardly need say. The crowd of earnest-looking and eagerly attentive listeners whose faces are directed towards the platform as the face of one man forms a spectacle not to be forgotten. Some of the best popular lectures which have been published in recent years were originally thus delivered. This praiseworthy endeavour to bring together the high priests of science and the industrial populations who are engaged in carrying out into practical effect the great scientific applications of the day was first commenced by Mr. Justice Grove at Nottingham in 1866, he being president of the British Association that year. At the next meeting Professor Tyndall (the president for the present year) gave one of his most animated and vigorous discourses to the working men of Dundee. In Norwich in 1868 Professor Huxley lectured on a "Piece of Chalk" (afterwards republished in his *Lay Sermons*). Sir John Lubbock, one of the most attractive of popular lecturers, addressed the artisans of Liverpool on "Savages" in 1870; Mr. Spottiswoode, one of the best physicists of the day, lectured to the working men of Brighton on "Polarisation" in 1872. Professor Williamson, Dr. Carpenter, and Professor Tait, have also delivered addresses since then; and last year, at Sheffield, there was quite a crowd of working men to hear Professor Ayrton discourse on "Electricity as a Motive Power."

Formerly the president of the British Association, in his inaugural address, was wont to present a kind of review of the progress each science had made during the year—"to take stock," as one of them termed it. However useful to the intelligent public this custom was, it became more difficult year by year owing to the gigantic strides which each science made. At length it was found impossible to crowd into an hour and a half's address even the barest outline of scientific discovery and invention, and now each president confines himself to such subjects as his hearers know that he is best acquainted with.

In order to facilitate the work of the meeting the Association splits itself up into seven sections named after the first seven letters of the alphabet. Thus mathematics, astronomy, and physics occupy the attention of the first, chemistry of the second, geology of the third, biology of the fourth, geography of the fifth, ethnology of the sixth, and mechanical science of the last.

As early as eight o'clock in the morning the "reception room" is opened, and here the temporary post office delivers letters. A daily "journal" can there be procured, in which will be found the lists of papers to be read during the day in each section. The sectional proceedings terminate at three o'clock, and from that time the members are free until about eight, when the lectures, *soirées*, etc., commence. The reception room in its busy hours is an animated and interesting scene. On the opening day it is crowded. People who have not seen each other for twelve months, but who may have been crossing swords in the pages of some scientific journal meantime, are shaking hands, each perhaps mentally taking stock of the ravages which the common enemy has made on the other in the interval. Other matters of interest move the spirits of the throng in the reception room on the succeeding days. Everybody seems anxious to hear or to tell some new thing. Readers of papers are continuing the discussion which was abruptly terminated in the section-room. An enthusiast who has a crotchet to ventilate is perhaps forcibly button-holing two or three unwilling listeners too courteous to deny him. Meanwhile notable introductions occur, and scientific men from different parts of the country or different quarters of the globe, engaged perhaps in the same scientific pursuits, known to each other by fame and perhaps by epistolary correspondence, are meeting for the first time in their lives and laying the foundations of personal friendships.

At the scientific *soirées* the most eminent naturalists, geologists, astronomers, mathematicians, chemists, geographers, and engineers in the world, assemble. They represent the high-water mark of scientific thought and enterprise. One wears a green shade over the eyes, having nearly lost his sight peering through the optic tube at the world of the "infinitely little." Another is a bronze-faced traveller who for many years has been living among savages in order to trace the course or origin of an unknown river or to mark on the map the boundaries of a great and hitherto never-heard-of lake. He is talking to a man who has also been a voluntary exile for years, collecting the plants and insects of a strange land. By and by as you move through the well-dressed and chatty throng you encounter a *savant* prematurely old, his pale face wrinkled and puckered in lines of thought. He has devoted his life to abstract mathematical investigations. Here is one with an unusually broad and square forehead whose name as an engineer is world-wide, who has spanned the largest rivers with bridges, tunnelled through the hearts of the highest mountain ranges, or cut a canal from one sea to another. By his side is a famous chemist looking a score of years older that he really is. That pallor is due mainly to the fumes breathed in the laboratory. You may be almost certain that the group of ruddy-faced, cheerful men laughing together in one corner of the hall are geologists or naturalists. The learned company is perhaps diversified by one or two angular and spectacled ladies whose appearance does not belie the conventional idea of the "blue-stocking," although there are many others of the fair sex in the company not less learned nor distinguished, nor in any respect less graceful or beautiful than their unscientific sisters.

Not every reader, even among those well acquainted with the history and the doings of the British Association, has heard of the "Red Lion Club." This celebrated society is now somewhat on the wane. Its originator was Professor Edward Forbes, a man who took such a hold on the affection of his scientific *confrères* that though he has been dead nearly a quarter of a century, his memory is yet fresh in the minds of those who were personally acquainted with him. About forty years ago he was a rising young man, and like many others about him who attended the meetings, not overburdened with cash. The dignitaries of the Association were just beginning to be recognised by municipal authorities, and invited to big dinners, the younger scientific men being left out in the cold. Thereupon Forbes and a few kindred spirits determined to start a club of their own, at which beefsteaks and stout or ale should form the *pièce de résistance*, with whisky toddy to follow, accompanied by songs and ballads, mostly *impromptu*, with witty parodies of scientific papers and lectures. The following year the club was duly and regularly founded, and some of the rules of the *Maga* club, which had been instituted at Edinburgh by Forbes and others when he was a student at the University, were dovetailed into those of the "Red Lions." The name was derived from the sign of the tavern where the first beefsteak supper was held. The members of the new club were all rising men, and their company as well as their club began to be sought after. The doings of this gathering of scientific good fellows presently became somewhat famous, for in the exuberance of his imaginative fun Forbes had introduced a system of ludicrous mock-masonic mysteries and practices. Some of these still cling to the "Red Lion" Club, although many young naturalists are prevented from joining by the half-guinea annual dinner, for the club has unwisely forsaken its primitive diet of beef and ale, and taken to "courses." It has, also, lost one of its most cheerful members in the person of Professor Rankine, whose Jove-like head never looked so grand as when he was singing one of his own songs among the Red Lions. For several years Rankine was "Lion-King"—the equivalent of "chairman" in the language of men.

The young provincial naturalist, who has looked up to the leaders in science with reverential awe, is a little taken aback when he is first introduced to the "Red Lion" Club. Whilst dinner is being served or waited for, leonine, ursine, and hippopotamine grunts and roars are heard, and the affrighted, perspiring waiters start as they are serving the soup to some rampant "Red Lion," and get a sharp snarl and snap instead of the ordinary "thanks!" Grace before meat will perhaps be spoken by the "Lion-Chaplain" thus:—"Brother lions, let us *prey!*" The chair and vice-chairs are filled by men distinguished in the scientific world, who seem to enter into the rollicking fun of the thing with all the zest of minds that have not been so unbent for twelve months. The speeches overflow with wit and broad humour, and are responded to by the leonine roars of the audience, who growl and wag the tails of their dress-coats in approval.

The railway companies usually allow the members of the Association to travel over their lines to the place of meeting at reduced fares on the production of their members' tickets. Of late years, Belfast, Bristol, Glasgow, and Dublin have been the most attractive places where the meetings have been held. The Naturalists' Field Club of Belfast is the most active in Ireland, publishing a yearly report, with papers read and excursions made, of more than usual interest. We hardly need say that the neighbourhood abounds in general as well as special interest, for at a short distance are the Giant's Causeway, the wild Antrim coast, and antiquarian and historical incidents superabundant. The coast is zoologically and botanically rich, whilst the chalk in such places as Woodburn Glen yields abundance of characteristic fossils. The Cave Hill quarries, Deer Park, Mountstewart, Grey Abbey, etc., are well-known botanical collecting grounds. The basalt, which has contracted in cooling into the polygonal pillars that have given its popular name to the Giant's Causeway, is of Miocene age, and forms part of the same old lava sheet that has produced such scenic effects about

Edinburgh, which crops up in Fingal's Cave, and forms a submarine plateau that emerges in the Faröe Islands, and is possibly continued into Iceland. It is the last evidence we have of active volcanic disturbances in Great Britain, occurring, however, during a period we may consider as geologically recent. The basaltic rocks in the north-east of Ireland undoubtedly present the grandest display of volcanic strata in Great Britain. They cover nearly the whole of Antrim, which county thus lies buried beneath an old lava sheet. Its average thickness is over seven hundred feet, and the chalk on which it rests is frequently to be seen altered from its usual earthy appearance into a crystalline or granular structure owing to the intense heat and pressure it has undergone during the ancient volcanic overflow and disturbance. The basalt of the Giant's Causeway contains seams of Lignite, or brown coal, the representative of the vegetation which flourished here during the Miocene period. In other places this old lava stratum contains iron ore, in which (as at Templepatrick) may be found the fossil remains of plants and insects. These well-known geological areas were visited during the meeting, and tolerably full details were given of what was to be looked for in the shape of minerals, fossils, plants, etc., that being the custom adopted by most Local Committees for supplying their visitors with as full a description of the scientific features of the localities as possible.

The pilgrims leave their mark upon the localities which they visit. A spurt is given to scientific investigation and inquiry, which is usually visible during the succeeding winter months. Those who are interested in science will then utilise the encouragement and popularity they have enjoyed to organise scientific lectures. Young students are made by these meetings, and older students take fresh courage.

CHAPTER XVI.

THE NORFOLK BROADS.

MORE localities in Great Britain are unacquainted with the footsteps of the tourist than otherwise ; for but few take a walk from "John O'Groat's to the Land's End." Here and there, sparsely scattered through the length and breadth of the country, are places of historical or traditional attraction, and on these the interest of the holiday-seeker is usually concentrated. We Englishmen like to have such spots chosen for us, and are conservative enough to esteem it as unfashionable to visit out-of-the-way localities, as it would be for a Belgravian to canter through Whitechapel. Generally speaking, we require an old ruin, a mineral spring, or a long track of dazzling yellow sea-sand, as a peg to hang our visit upon. Whilst we are asking, "Where shall we go this autumn?" the usual tracks of travel, from Dan to Beersheba, are so worn and beaten that we are forced to cry, "It is all barren!" Holidays are spent in going over old grounds which possess as much interest for us as travelling through a railway cutting. True, some of our more adventurous spirits have mapped out fresh fields of recreative research, and the "wilds" of Norway, Canada, and even Africa, are not unacquainted with the ring of merry English voices.

Not long ago, a magazine article on "The Wilds of Cheshire" suggested the description of new ground to those who are adventurous enough to try it. "The Wilds of Norfolk" are even more striking than those of Cheshire. In many parts of Great Britain there are spots resembling the latter; but Norfolk stands alone in the character of its "Broad" scenery. Walter White, in his pleasant, gossiping volumes, has dwelt upon it enthusiastically; but it is necessary for a man to live in Norfolk thoroughly to enjoy the topography of the Broad district. Wilkie Collins, in his *Armadale* has given a slight but graphic sketch of one of these Broads, but his picture does not lie on the canvas long enough to be sufficiently enjoyed. In his own way, also, Charles Kingsley has adverted to many of the salient features of the Fens, in *Hereward.* The district, however, we are about to describe lies more inland than that which this well-known writer laid down as the scene of his hero's exploits. One local work has directed attention towards the Broads—Lubbock's *Fauna* of the same county. In it there are good bits of word-painting, sufficient to induce a man who is careless about the fashionable reputation of his holiday places, to see the Norfolk Broads for himself.

The "Broad District" proper is included within an almost equilateral triangle, having the sea-coast for its base, and its two sides drawn from Lowestoft to Norwich, and from Norwich to Happisburgh. Within this area there are no fewer than fourteen large Broads, besides groups of smaller ones. The principal of these natural sheets of water are Surlingham, Rockland, Breydon, Filby, Ormesby, Rollesby, Hickling, Barton, Irstead, and Wroxham Broads. With the exception of the extreme north-western parts of the county, Norfolk is exceedingly flat. Formerly, this tract was so much under water that the marshes through which the rivers now flow were formed out of peat which then grew as aquatic weed. In most of them when a bunch of grass is pulled up, empty freshwater shells are found adhering to the roots. All the rivers have a very low fall, and consequently meander about the country before they find an outlet into the sea. The tidal wave enters their mouths and comes up for a great distance, causing the fresh water to "back up," so that ebb and flood tide are felt many miles beyond where the water has ceased to be brackish. Were any of those geological changes of which we have heard so much to occur here, and Norfolk to settle down a dozen feet or so, by far its greater portion would be submerged. Here and there, where the land lies lower than usual, the rivers all but stagnate. Their waters spread out into natural sheets or lakes, and are vernacularly termed "Broads." These are the "Wilds" we have chosen to treat upon. They resemble each other so much, that a description of the principal features of one would almost serve for the rest.

Notwithstanding the magnitude of the larger Broads, few of them have a greater average depth than eight feet, the majority being even shallower still. They are, for this very reason, exceedingly favourable to the growth of a luxuriant aquatic vegetation, so that a greater area is covered by sedge and bulrush than by water. These form a splendid cover for snipe and innumerable species of aquatic fowl. The Broads, however, are not what they formerly were. The last hundred years have seen them greatly altered,—the agriculturist will say for the better, the sportsman will say for the worse. Anyhow, the marsh lands bordering them have, in many cases, been drained and turned to good purpose; whilst, since the introduction of the American weed,—Anacharis,—into this country, turf has been forming at a more rapid rate, causing the area of the

Broads to be greatly encroached upon. What will be the result in another century it is difficult to tell, but meantime we recommend a visit to a locality where so much of the country exists now as it did when the Iceni inhabited it, and where a man may imagine he is no longer in England.

The sportsman who has spent a fortnight in fishing and shooting over the Broads, will smack his lips ever afterwards at the very remembrance. There he finds water-hen and coot in abundance, snipe of two or three species rising and twittering at every few steps, wild duck and teal whirring from amid their sedgy covert, or splashing farther into it. Pike of a score pounds weight may be captured, and lordly perch that will give a good half-hour's play. Bream, roach, and eels in various places swarm the waters, whilst for size they can hardly be equalled anywhere else in England. In this district it is not uncommon to hear anglers speak of their finny captures by the "stone!"

Not the least important item about these Broads is that they may be visited cheaply. A flat-bottomed boat, roomy enough to hold a cart and horse, can be hired for a shilling a day. If the visitor care to have a companion who knows every square foot of the country, he cannot do better than take one of the marshmen with him, who will be glad to accept half-a-crown for his day's services. These men are civil and exceedingly shrewd. They know every phase of local nature, and the habits of every fish, fowl, or four-legged animal in their neighbourhood. Marshmen are a distinct variety of the genus Homo, for their general isolation from society, and their habit of spending so much time alone, make them naturally taciturn. They can, if they wish, wile away the hour by many a sporting or poaching adventure, told in the naïve, racy, Norfolk dialect. The visitor, however, must be careful about the way he strikes a fish or knocks over a snipe, for these men are exceedingly critical on these matters, and, although they may not say much, their supreme smile at any discomfiture is not calculated to improve an irritable temper.

We will suppose you, gentle reader, to be the sportsman aforesaid, that you have made all necessary arrangements for an excursion, and that you are about to start from the improvised pier near the marshman's cottage on your expedition. Gun and angling-tackle have been stowed in the boat, and your companion begins to pull through tall thickets of bulrush and sedge, the watery lanes extending through them for miles. Many a shot may be had by the way, for the marshman will row as noiselessly as if he had muffled oars. It may be that the cut on which you are floating has a sudden bend. If so, at the turn you will be certain to see half a dozen coot sporting and frolicking about. Quick! or all that is visible of them will be their white rumps, and a few bubbles indicating where they disappeared! Should you go in the early morning, or late in the evening, wild duck will be feeding. If you lie concealed a short time before, somewhere opposite to the wind, the chances are that you will make a good bag. Proceeding on your pleasant voyage many an uncommon object will arrest your attention. Here and there the stately heron stands like a statue. He rises lazily as you approach, and slowly flaps away over the tall bulrushes, to continue the process of digestion in a quieter spot. The peculiar cry of the bittern is occasionally heard from amid the reeds, although this bird, as well as the little grebe, is now becoming very rare. The king-fisher is still abundant, notwithstanding that his attractive colours cause him to be remorselessly shot down. He flits across the channel where you are rowing, his brilliant plumage glittering in the sunshine until he looks like anything but an honest English bird. The reed sparrows twitter and chirrup, and hang to the sedges, where they are swayed to and fro by the wind. Here and there a black-headed bunting pretends lameness in order to lure you away from its nest. The length of the reedy cut loses its monotony by these various incidents, and presently you see it opening out into a magnificent sheet of water, dotted with swampy islands, and set in a framework of tall sedge and dwarfed alder or willow. The eye readily catches a glimpse of many species of aquatic fowl sporting on the surface, but, strong though the temptation may be to make towards them, the attempt would be perfectly useless.

The boat glides over the Broad to some favourite spot known only to your companion. Here he thrusts down into the mud the two long poles he brought with him, and makes the boat fast to them. Below, in the clear water, you see shoals of fish,—roach, perch, or bream. No sooner has the gut been wetted than "bob" goes the float, and your capture is separated from you only by the length of your rod and line. This, perhaps, is a part of the Broad which your friend has repeatedly "ground-baited," so that you may confidently reckon upon good sport. The great glory of the Norfolk Broads, however, is their pike. The usual plan of taking them is by "liggering" or "trimming," and, destructive though this method is, they do not seem to be less abundant in consequence. There are several kinds of "liggers," but the following is the most common.—Be provided with good store of strong twine, and plenty of pike-hooks attached to gimp. Then take a bait,—roach is the best,—and pass the gimp by means of a needle just underneath the skin, until the hook is drawn quite close to the head of the fish. The end of the gimp is made fast to the cord. About a foot above the bait is a perforated bullet to sink the line, and three or four feet higher still, according to the depth, the cord is tied round a bunch of dry weeds, so as to represent a huge float. One end of the line is then made fast, and the entire apparatus is thrown into the water. No sooner has the roach returned to his native element than he makes desperate struggles to escape. This attracts the attention of some pike on the look-out for a feed, and, as this fish never scruples to take advantage of his prey being in a pickle, he snaps at it immediately. Down goes the impromptu float, and the pike, finding he is caught, gets to the end of his tether, and there quietly remains.

It is a usual plan for local sportsmen to go out purposely for a day's "liggering." In that case no angling is attempted. Two or three score liggers are put out in various parts of the Broad, and, by the time the last is laid down, it will be necessary to take the first up. The whole day is thus busily spent, and the general average of fish so captured will be perhaps one half of the number of lines laid out. As many as threescore pike have thus been taken in one day. Not unfrequently, when the eager sportsman rows up to a submerged float, and cautiously hauls in his line, his heart palpitates as he beholds a huge pike slowly rolling over and displaying his belly. Just as he draws him to the surface, a pair of enormous jaws are displayed, there is a sudden whirl of the tail, and the monster has disappeared! Instead of the capture reckoned upon, behold a young jack of a couple of pounds! With the ravenous hunger of his tribe, superadded to that of his juvenility, he had taken the roach, and got himself into trouble. Whilst replacing the original bait, he had been swallowed by a cannibal neighbour, out of whose capacious stomach he had been regretfully hauled. The intending capture, disappointed of a meal extracted in so strange a way, has hastened to the weedy depths below, there to meditate with pike-like taciturnity upon the strange experience which has just befallen him! Mr. Cholmondley Pennell will lift up holy eyes of horror at this unsportsmanlike way of taking the pike. We are, however, only humble chroniclers of actual facts. Even he would find "spinning" at a discount, although on the very deepest Broads. The weeds are so numerous, and the water so shallow, that all his time would be occupied in disentangling the spoon or artificial bait, not from the gorge of the pike, but from the clutches of anacharis and potamogeton. True, the navigable streams which usually run through the Broads are kept pretty clear from these entanglements, and here, in the months of September and October, some splendid and more legitimate sport may be had.

In eel-fishing, we are not aware that the laws of angling have laid down any rule, except that famous one of Mrs. Glasse. In this department, at least, it is fair to take your fish any way you can, the only important point being that you do take it. For many fishermen who regard it as a breach of morality to take a pike otherwise than by spinning, can look upon eel-spearing and eel-basketing with supreme indifference. The muddy bottoms of the Broads, and the innumerable insect larvæ which feed upon the aquatic vegetation, surround the eel with every favourable circumstance for his physical development. Accordingly, nowhere do we find eels so large and fat as in these localities. The best bait for them are small dace and roach, which are usually obtained for that purpose with a casting-net. On the Broads, towards six in the evening, you will frequently see a couple of men in a boat busily engaged in making fast to the weeds one end of a long line. Their boat is then thrust off, and the line paid out for forty or fifty yards, when it is sunk by a weight. Along it, at intervals of every three or four feet, a series of strings is fastened, to each of which a hooked bait is attached. These are all allowed to lie on the bottom, and, as eels generally move about between dusk and midnight, the greater part of the bait may be taken before morning. Thirty or forty hooks are usually attached to a single line. Early next morning the men return to take up their primitive snares; and no small task it is; for the captured eels will have wriggled round the weeds or dug themselves into the mud; so that, unless caution be used, it is more than probable the lines will be broken and the greater portion of the spoils lost.

Another way of taking eels, and by far the more ingenious, is that known as "babbing," or "bobbing."

A series of large worms is strung on cobbler's worsted and coiled into a knot. This is fastened to the end of about six feet of strong cord, and a weight is attached about three inches above the bait. The line is then tied to the end of a stout hazel-pole; and, provided with this simple tackling, about nine o'clock in the evening you row to a part of the river or Broad where there is a tolerably clear bottom. Having made fast the boat, and of course lit a pipe as a preliminary, you gently let down the line until you feel the bottom with the weight. It is then drawn up again until the bunch of worms just trails on the ground. Many minutes will not have elapsed before you feel an electrical sort of jerk travelling down the pole into your right arm. Another tug, more powerful than the former, and quickly, but without any plucking, you raise the line over the boat, and in flops a big eel! We have known a couple of "babbers" to take as many as two or three stone of eels in a single night. No small amount of practice is required to drop your prey into the boat. If the eel happen to be unusually large, the chances are that you tug at him so strongly that, when you lift him out, the impetus carries him over the boat, and drops him in aqua pura on the other side! We have enjoyed few sports more than "babbing." The clear starlight overhead, the sighing and soughing of the wind among the reeds, the ripple of the water against the boat, and the strange sounds which break upon the ear of night, are calculated to produce an effect upon the mind never to be forgotten.

The nearest Broad to Norwich, Surlingham, is five or six miles from that city. It is not very extensive, averaging about a hundred acres. Its communication with the river Yare is by a series of small channels, as is also the case with Rockland Broad, about two miles lower down. Some decent shooting and fishing are still to be had here, although the near neighbourhood of the railway has greatly affected them for the worse. Surlingham Broad is a frequently-visited spot by the botanist, inasmuch as that rare fern, *Lastrea uliginosa*, grows in abundance on one of its reedy islands. In the summer time, every channel is lined with the tall stems and blooms of the Flowering Rush, the Yellow Iris, the Water-violet, the Arrow Head, and the Water-plantain. The greater portion of every Broad is aglow with white and yellow water-lilies, peeping out of cool leaves, and underneath which you might fancy "Sabrina fair" to be sitting, were it not that the water is too shallow! With the exception of Hassingham Broad,—privately preserved,—there are no other Broads between Norwich and Yarmouth. "Breydon Water," as it is commonly termed, where the Yare and Waveney join previous to their debouchure into the sea, may rank as one, although it is so affected by the tides that it cannot be classed among the freshwater lakes. In the winter there is some fine shooting to be had here, and not bad fishing during the summer. But, to get into the " Broad district" proper, you must go up the river Bure, which also empties itself into the sea at Yarmouth. This river is more sinuous than any other, owing to the general flatness of the country through which it passes. Considering this, however, the scenery is tolerably diversified and agreeable.

Travelling up the Bure, in a north-westerly direction, you reach Filby Broad, at a distance of about five miles from Yarmouth. This spot has long been famous for its wild duck and teal ; its neighbourhood to the coast making it a splendid shelter for these birds. Its fishing is not less abundant, and although this Broad only extends over an area of one hundred and sixty acres, its narrow and sinuous character makes it appear much larger. It is divided from Ormesby Broad,—preserved on account of its being the main water supply to the town of Great Yarmouth, —by a narrow road-bridge. With the exception of those at Barton and Wroxham, there is no Broad in Norfolk so picturesque. Indeed, were the vegetation a little less English, you might easily imagine yourself upon one of the Italian lakes! Horsey Mere, although only a few miles distant from Filby as the crow flies, is a long way by water, and you will have to leave the Bure once more to reach it. Still higher up is Hickling Broad, the largest and most extensive in the county, being above three miles in circumference. Its bottom is gravelly over its entire area, so that pike and perch are very abundant in it. But, with the exception of the deep channel running through its midst, along which the tan-coloured barges sail, Hickling Broad is so shallow that a man might wade all over it without sinking lower than the armpits.

Returning to the Bure again, you presently reach South Walsham and Ranworth Broads. Both are exceedingly picturesque, and each is connected with the main river by long reedy channels. The latter Broad was, until quite recently, a successful duck decoy ; whilst the former is noted for its eels, perch, and tench, as well as for its neighbourhood to a magnificent ruin, that of St. Bennett's Abbey. South Walsham Broad is divided into two sheets, connected by a strait termed " The Weirs." The further portion is richly wooded down to the very water's edge. The last time we were out on these Broads, the " salt-water tide," as the natives term it, had flowed higher up the river than usual, and the surface of the water was strewn in some places by pike, of from two to eight pounds weight, which had died in consequence. These periodic " salt tides " do immense harm to the freshwater fish.

Leaving the Bure, and sailing up the Ant, the next Broads we come to are those of Barton and Irstead, which, in magnitude, approach nearest to Hickling, but are far more picturesque. These Broads are also connected with each other by a narrow strait of water. Both possess great attractions for the botanist on account of their many rare plants. Nowhere, perhaps, do perch attain the size they do here, three-pound fish being not uncommon in the deeper parts. The swampy margins of these Broads are pea-green with the little marsh fern (*Polypodium thelypteris*), whilst great thickets of the royal flowering fern (*Osmunda regalis*),—truly so called,—seven and eight feet high, give to the shores almost a tropical appearance! In the evening the aromatic odours of the Sweet Gale, whose arborescent underwood covers the turf, are wafted over the lake with delightful effect. The Bladder-wort also,—always an interesting botanical prize,—is tolerably common here. With these associated floral and other rarities, it is not surprising that the Lepidoptera should be equally various, or that the entomologist should make his best captures in such a neighbourhood. Numbers of entomologists frequent the neighbourhood of Horning Ferry, for the purpose of taking that exquisitely beautiful insect the swallow-tail butterfly (*Papilio Machaon*). The principal Broad through which the river Bure passes is that at Wroxham, about seven miles distant from Norwich. The water is deep enough here for an annual regatta to be held, which is always a source of attraction to Norwich people. Walter White has given a lively description in his *Eastern England* of one of these "water frolics," as they are locally termed. Indeed, a man who has seen this sheet of water, with its rich framework of fine old trees, is not likely soon to forget it. The effect is considerably heightened by the light river yachts, with their snow-white sails, and by the concourse of people who attend the regatta.

Besides the above-mentioned Broads, there are minor ones at Salhouse, Belaugh, Ludham, Mautby, and a dozen others smaller still, which more or less fringe the coast from Winterton to Happisburgh. The most economical, and yet the most effective way, to explore these regions unknown to Cockneydom, would be to hire a yacht for a fortnight, with a man to sail it. Then, to your heart's content, you might shoot, fish, botanise, or sketch. Anchoring at a different place each evening, fresh scenes and objects new would always be met with. Occasional visits to scattered villages, with their round- and square-towered churches, rich in archæological treasures, would form an agreeable relief. Altogether, in these not far-off "Wilds of Norfolk," the not too particular adventurer will find such various sport as he is not likely to get anywhere else in old England.

CHAPTER XVII.

OLD WINE IN NEW BOTTLES.

MANY times we are tempted to put a literal construction on the old-world saying—"There is nothing new under the sun." The chief difference between the ancients and moderns almost seems to lie in the fact that we have better means of carrying out our ideas than they had. It is really surprising what a multitude of old friends may be recognised under ancient masks. Ideas which have been filtered through millions of minds, which have dropped through one language into another, have had the time, place, and person on which they hung all removed, still remain in substance unchanged. What philologists say of "word-roots"—that they may be recognised in a hundred languages, in spite of their metamorphoses—might be applied with equal force to some of the best thoughts and brightest witticisms of modern times. The parallel might be carried farther. These "word-roots" stretch back to the primitive Aryan language; and, in like manner, many of our modern ideas can be traced to ancient authors. Among these the Greeks come first. But whether they struck them from their own mint, or literally "spoiled the Egyptians" to obtain them, we cannot tell. Human nature takes a long time to alter; and it is likely enough many of these classic writers were as great plagiarists as ourselves.

Those two modern sciences, comparative philology and comparative mythology, have played sad havoc with the speculations of the last century—those to which all of us are more immediately wedded. We are called upon to put aside the works on the origin of language, and the identity of pagan traditions with scriptural characters and narratives, or must retain them on our shelves for the sake of the good English they still teach us. Amid all the maze of myth, language, and religion which so long has perplexed the philosophic mind, we are tracing the thread which will guide us so as to find our way out. Mankind, with its host of languages and religions, its civilisations and barbarisms, seems nevertheless to have had a common legacy of old-world ideas. From grave to gay, from lively to severe—nearly all kinds of modern ideas find their representatives in the literature of antiquity. The most dazzling of our systems of philosophy would have been baseless without those of Aristotle, Socrates, and Plato. But we little imagine how much we are indebted to the Greeks for the very tales which for so long have been effectual in setting " the table in a roar." That such is the case, however, any student of out-of-the-way Greek authors who has read Hierocles is well aware.

This classic " Sidney Smith" was the great opponent of the Sophists, and did for them exactly what our own *Punch* would have, had his comic lordship then been in existence. The pedantic pride of that sect raised the bile of the cant-hating wit, who accordingly made them the butts of his jokes. Many of these were so good, that they have been in existence ever since. All the circumstances, the auxiliaries, have been changed ; but the substance of the jokes has not evaporated. We have decanted this old wine repeatedly ; but it has proved none the worse for the process. Strange enough, many of our modern Joe Millers are merely free translations of Hierocles' jokes, although few readers or utterers of the former are aware of it. No tale is anything without a peg to hang upon. This peg our ancient jester found in the Sophists, or *Scholasticus;* we discover it in Irishmen. It is really astonishing what a number of " bulls " we habitually refer to the natives of Hibernia, which were fathered more than two thousand years ago on people who were forgotten long before Irishmen were known. In taking a few commonplace ones it will be impossible not to perceive their identity. Thus, there is the story of the Irishman, who having narrowly escaped drowning, declared he would not go into the water again until he had learned to swim! This dates before the Christian era; as also does the tale of the "gintleman" in distressed circumstances, who decreased the feed of his horse until it came to a straw a day, when, much to the chagrin of its master, "Be jabers, just as he got to do widout food at all, the cratur died!" We have heard this story repeated so often, that it has become quite solemn. Another "cock-and-bull" tale is that told of an Irishman who had a house to sell, and therefore frequented the market-place with a brick and a chimney-pot as samples of its quality! The ancient Greeks shook their sides at its ludicrousness when *Scholasticus* took the Irishman's place. The coincidence between ancient and modern *bon-mots* may be carried still farther. One of the most laughable of the tales told of these classic pedants—who were always popularly represented as making fools of themselves, in spite of their learning—was that in which a member of their body has an adventure with a barber and a bald-headed man. The barber seems to have been fond of practical joking; for during the night he arose and shaved Scholasticus' head to the same condition as that of his sleeping companion! The tale runs on to tell how the philosopher had to get up before the rest to pursue his journey, and accordingly was wakened early for the purpose. No sooner was he aroused than, putting his hand to his head and finding it denuded of its hirsute covering, he declared they had wakened the *wrong man!* Nearly a similar story is told nowadays of an Irishman who, being on the "tramp," practically realised the truth that travellers become acquainted with strange bed-fellows. In stopping at a village inn, he found himself obliged to sleep with a negro. During the night some wags blackened his face; and Paddy, having to be called early, rose and went on his way, as usual unmindful of ablution. After he had got some distance on the road—so runs the common story—he accidentally saw his blackened features in some water by the way side, when he immediately returned, declaring they had wakened the "wrong man afther all!" It is impossible not to see the clear connection between these two tales, although upwards of twenty centuries elapsed between their telling. Again, who has not heard the story of the two Hibernians who, having twenty miles to walk before they reached London, and being dead-beat, cheered each other by declaring it was only ten miles apiece? There are few of us who have not fallen into the trap of uttering something like this as original. The ancient Greeks, however, told the tale of *four* Sophists; and the joke has passed, on its way to England, through Italy and France. In each country it has been slightly modified, although the same point of wit has always been preserved. Then come one or two other stories of even commoner repetition, such as that of an inquisitive Paddy, who heard that ravens lived two hundred years, and accordingly bought one to try! Alas, this is only another instance of the social tyranny we are in the habit of inflicting upon the sons of the Emerald Isle; for the same tale was told long before the advent of the Christian religion. The narrative of the Irishman who sat down with shut eyes before a mirror, to see how he looked when asleep, is equally antique.

Let us render social justice to Ireland, if we have hitherto found it difficult to administer political. Notwithstanding the erratic tendency to blunder peculiar to his race, it is hardly fair that modern ridicule should lay all these ancient bulls on Pat's broad and good-tempered back. When we think of the flashes of merriment which these old jokes have made across the social and intellectual darkness of the intervening ages, we cannot but be thankful for them. "There is a time to laugh," says the Wise Man, and the world instinctively seizes hold of the opportunity. Jokers and punsters are therefore as necessary to its well-being as individuals of more ambitious talents. Puerile and feeble though many of the witticisms we have mentioned may be, human nature could not afford to let them die. It is too fond of an occasional ray of laughter to solemnly bury what produces it, and therefore has carefully handed it down as a legacy from one generation to another. But there is a dark side to this antiquity of jokes, as well as a bright one. We have not only preserved all the good old wine, and rebottled it in more attractive magnums—we have also received a legacy of unfit beverage along with it. The weak-minded and "fast" young men, who prime each other with tales and narratives unfit for their mothers and sisters to hear, are little aware they are retailing merely the dregs of Aristophanes, Boccaccio, Rabelais, or La Fontaine! All the genuine wit and humour which this morality *in extremis* was lugged in to illustrate has been forgotten or lost sight of, so that the narrators have not even the merit of originality in their lasciviousness!

But not only are many of our jokes, good and bad, as "old as the hills," but our fables are generally still more so. This is a fact in literature so well known generally as to require little proof in these pages. Æsop's fables will live as long as the world endures. The poets and writers of most European countries have gained another reputation, either by translating or paraphrasing them, to say nothing about their having served as models for similar and original attempts. In England, our own Gay transposed them in smooth native verse for the use of his royal pupils.

In France, La Fontaine translated them in his own sparkling champagny manner. Indeed, there are few fables in any civilised country which cannot be more or less traced to the ancient Greeks. This was a method of teaching morality very popular among them. Among those fables which undoubtedly have an outside origin may be mentioned that of Reynard the Fox. This has perhaps a greater antiquity than any in Æsop, although there is reason to suppose that many of his had floated as illustrations in popular folk-lore, before he fixed them as part of Greek classic literature. That just mentioned can be easily followed in European literature to the twelfth or thirteenth century, when it is lost sight of. But far beyond this period it had an immense Scandinavian antiquity. It has also been recently found among the South African Kafirs, with whom it has been naturalised for untold ages. So great was the popular influence of this fable in France at one time, that it changed the common name of the fox (*vulpes*) into that of *renard*, which it still retains as proof of the fable's former hold on the national mind.

This antique and, geographically speaking, widespread existence of certain fables or allegorical morals naturally leads us to the consideration of those old-world stories which have laid a common basis of tradition and legend in most European countries. There is something more important than the indulgence of mere curiosity in this investigation, interesting though that engagement may be. The scattered incongruous myths and legends which most civilised nations have in common give us a glimpse of the former unity which bound races together before their prehistoric migrations. The "whence and whither" of nations speaking a hundred different languages are frequently better indicated by their half-forgotten and much changed traditions than from their physiological resemblances. We have no hesitation in believing that the roots of many popular beliefs and legends extend backwards to the Palæolithic age, when savage man was companion to the woolly-haired Mammoth and Rhinoceros. Singularly enough, what comparative philology, in the hands of Max Müller and others, has so plainly indicated—viz. the origin of all European and Asiatic peoples from a common Aryan source—is more or less borne out by the still younger science of comparative mythology. The latter takes these obscure myths, compares and collates them, and out of seeming chaos brings forth unity of origin. The commonest differences in these family traditions are just those we might expect from our knowledge of the geographical distribution of animals and plants. These *incidentalia* naturally change in the tradition with the fauna and flora of the places where they are mentioned—modified much after the fashion that English colonists gave the names of "dog," "bear," etc., to the marsupial animals of Australia most resembling these well-known creatures.

How such a metamorphosis could be effected we have an illustration in the early history of Christianity. Milton, in his poem on the "Nativity," represents the pagan deities as fleëing before the introduction of Christian personages. But, as Lecky has shown in his *History of European Morals*, the opposite was probably the policy of the early teachers of the new religion. Paganism, with its gods and goddesses of the mountains, woods, and streams, had taken too deep hold of the popular imagination to be loosened by any mere didactic teaching. And so these fabulous beings were represented as evil spirits, now to be dreaded and shunned. The popular idea of the Satanic appearance, with its horns, hoofs, and tail, still exists, and bears undoubted traces of its origin from Pan. The fables which had grown around the pagan deities were Christianised, or excelled by the supposed miracles of saintly anchorites. Many of the old classic myths in this way become dressed in Christian garb, and as such swell our hagiology. From our old church and cathedral windows they look down upon us, and their symbols figure on ecclesiastical screens. No wonder, therefore, they should have taken such deep root in the mediæval mind, seeing they were perpetually before it, and always associated with its most solemn duties and engagements.

The ancient Romans undoubtedly borrowed from the Greeks to enrich their mythology, and the latter from the still more ancient Egyptians. Whence this "pyramid-building people" obtained them, we can only guess from the identity of some of their myths with those of the Hindoos. In many cases, from the latter to the Roman Catholicism of the sixteenth century, we have an unbroken, although greatly modified, sequence of legend. The close resemblance, amounting frequently to identity, of Scandinavian and Celtic myths to those of ancient Hindostan, is a wonderful instance of the assistance given by comparative mythology to the science of language and ethnology. It requires little logical perception to see there must have been some connection between peoples so far removed in time and space as the ancient Druids of Britain and the modern Javanese, as the following will show: The inhabitants of Java have a superstitious reverence for the *Ficus religiosa*—which tree receives its name on that account—because there grows upon it a species of mistletoe! With our own pagan ancestors it was the oak which received semi-worship on that account.

A French geologist has lately thrown out the idea that the huge fossil bones of anthropoid apes, etc., found so abundantly in the Miocene beds of Pikermi, near Athens, may have influenced popular belief in the tradition of the Titans warring against Zeus, and others of a similar kind. And it has frequently struck us that the tradition of a Deluge, certainly more or less believed in by every distinct nation or race, may have resulted in the dim antiquity of man, from the forced migration of the Palæolithic men, when the period known as the Glacial drove all mammalian life from the northern continents, and forced it to retreat to southern latitudes. A great part of Europe was then gradually submerged beneath a wintry sea, and it is an incontestible fact that land animals and plants had the only option of migration. If man were then in existence (and there is ample reason to believe he was), he would have been forced by circumstances to a similar result, and thus the hazy tradition of a mighty deluge, modified as the narrative is by every nation, would be common to all subsequent races.

The origin of myths, and their relative antiquity and meaning, has been popularly treated by the Rev. Baring-Gould in his *Curious Myths of the Middle Ages.* With great learning and research, that author has shown, in a style at once clear and attractive, the connection of many modern legends with those of antiquity. Who, for instance, would ever dream of finding the original of St. George and the Dragon in the Greek myth of Apollo and Python, or Perseus and the sea monster? This the Greeks doubtless borrowed from the Phœnicians, and the latter, possibly, from India, in whose most ancient literature we find it enshrined. The myth of the Wandering Jew—now so well known to us all from Doré's magnificent illustrations of this weird subject—was in the Middle

Ages applied to a hypothetical Jew who refused to allow the Saviour to halt at his threshold as He was bearing the cross. But the ground-work of this legend is considerably older than the Christian era. The story of the Seven Sleepers of Ephesus has both an Oriental and Scandinavian source. The idea of a miraculous sleep is not limited to these mythical individuals, but extends to Charlemagne, Thomas of Ercildoune (see old ballad), and Frederick Barbarossa. We find it shadowed forth in the traditions of North American Indians, and it was common property, ten centuries ago, to every country in Europe. Even the mysterious symbol of the cross—properly deemed so peculiarly characteristic of the Christian era—has an antiquity extending for centuries beyond the date when it was supposed to have originated. We find it connected with Hindoo mythological figures, and even engraved among Assyrian hieroglyphics. It was an ornament or symbol among the Etruscans, and has also been met with among the Mexican antiquities of Central America. Both among the Romans and Greeks it was well known, and the writer has seen it on British pottery considerably older than the Christian era. Singularly enough, there were varieties of the cross-symbol in ancient times, just as we have them at present. The sacred sign throws its protecting shadow backwards as well as forwards, as though it would shelter and protect all the races of mankind. The legend of the Piper of Hamelin is now well known to all English readers from Robert Browning's poem. But its basis is founded in very ancient myths, each of them having for its theme the power of music over the animate creation. We have the body of the story in the legend of Orpheus and his descent into hell.

But the most curious deduction from the spirit of these ancient myths is that made by the Rev. Baring-Gould, who detects the old Druidic theory of the soul's departure being accompanied by unearthly music, in the hymns of many of the English dissenting sects. Referring to that of the late Dr. Faber, beginning,

> " Hark, hark, my soul ! angelic songs are swelling
> O'er earth's green fields and ocean's wave-beat shore,"

he expresses his decided opinion, that the idea is undoubtedly founded on this ancient superstition. He continues this explanation in his article on the " Fortunate Islands ;" wherein, referring to the Celtic idea of the souls of the departed passing across an unknown sea—an idea we have, by the way, in the classic fable of Charon's boat—he quotes this as an illustration of the hold which ancient mythological doctrines relative to death still have upon the people, and shows how it is engrafted on popular religion in such hymns as—

> " Shall we meet beyond the river,
> Where the surges cease to roll ? "

We cannot forbear quoting the passage which treats on this singular and unlooked-for relationship between ancient and modern religious idea. "A careful study of these sources will, I am satisfied, lead to the discovery, that under the name of Methodism we have the old Druidic religion still alive, energetic, and possibly more vigorous than it was when it exercised a spiritual supremacy over the whole of Britain. With the loss of the British tongue, much of the old terminology has died out, and a series of adaptations to Christianity has taken place without radically affecting the system."

Farther, Mr. Gould tells us that it is a fair subject for inquiry whether the popular iconography of the angel-hosts is not indebted to ancient tradition for its most striking features. Another heathen myth is "embodied in the tenet that the souls of the departed become angels. In Judaic and Christian doctrines, the angelic creation is distinct from that of human beings. According to a Druidic dogma, the souls of the dead were guardians to the living; a belief shared with the ancient Indians. Thus the hymn, 'I want to be an angel,' etc., so common in dissenting schools, is founded on the venerable Aryan myth, and therefore of exceeding interest, but Christian it is not." The very basis of so-called "spiritualism," therefore, lies not in Christian, but in the old Druidic dogmas. Truly there is "nothing new under the sun."

The oft-repeated, and still much believed in, stories of mermen and mermaids are as old as the days of the Philistines, whose god Dagon, represented as falling to pieces before the ark of the Lord, was symbolically represented as half-fish, half-man. The same idea is expressed on Assyrian and Hindoo sculpture. Many old tales, which have been reduced to the level of nursery rhymes, have an antiquity even greater than this notion. In the youth of the world, when the poetic spirit was strong upon it (if Lord Macaulay's theory be true), the only way in which natural phenomena could be popularly expressed and understood would be in trope and allegory. We have a remnant of this personification even now, in our masculine and feminine gender for the sun and moon. Most of the old myths resolve themselves into physical explanations of natural phenomena. Afterwards they became crystallised apart from the subjects to which they primarily referred, or were sublimed into the regions of tradition. And lastly, when inquiry and experience had put many relations on a better-known footing, we should have these very legends and stories exiled to a separate condition of their own, still to be drawn upon, however, as one means of awing the vulgar crowd.

CHAPTER XVIII.

THE COUNTY PALATINE.

WHEN we consider that on all hands Lancashire is allowed to be one of the most important counties in Great Britain, it is surprising how little most outsiders know of its real character. We have a vague idea it is a land fruitful in tall factories and ugly collieries; and have seen caricatures of it in the London drama intended for accurate representations. There we have been introduced to underground and factory life, as believed in according to the rules of dramatic art. But the genuine Lancashire character remains unsketched, except in the pages of *Tim Bobbin*, or in the works of native authors, to which we shall presently allude. The typical examples have originated in the more southerly portions. Of the extreme north, a land of "fells" and "scars," little is known. Easterly, they blend into those of canny Yorkshire; whilst in the extreme south they pass into the softer features of Cheshire. The area in which we find Lancashire life and character in its normal condition is bounded within lines drawn from Manchester to Rochdale; thence to Bacup and Blackburn; returning again by way of Wigan. In various places the Pennine Chain, or "backbone of England," as these hills are called, throws off spurs which break the neighbouring country into ridgy undulations. Here the hard Millstone Grit rock crops out, with scarcely a foot of soil upon it, but still enough to find a luxuriant home for the purple heather and cackling grouse. Many of the vales, however, are agriculturally rich in produce; and the scenery is such as Old England rarely excels. None of our readers who have passed through the Vale of Todmorden will be inclined to deny this. The contrast between the bleak hills and the well-wooded valleys causes each to be more attractive. The Valley of Summerseat, beyond Bury, which divides itself into minor ones running sinuously among the hills, is another romantic spot. These smaller valleys are termed "cloughs;" and adown them, over masses of disengaged sandstone, the mountain torrents perpetually brawl. The smaller hills, or, rather, those of a more ridgy character, go by the name of "edges" just as the Spanish term similar elevations "sierras." The higher ones are denominated "pikes"—a corruption, doubtless of "peak;" and many others are called "lows," a slight corruption of the old Saxon word "Llaw," a hill.

But it is in the character of the inhabitants of this region that Lancashire is a county *sui generis.* They are marked off from any other by a peculiar idiosyncrasy, which distinguishes their general habits, customs, and recreations. The introduction of railways and machinery has done much to smooth down the angularities of character; but there are still sufficient left to individualise it. It existed in its unshorn strength rather more than half a century ago. In the old days, before factories had been built, and when hand-looms alone kept up the fame of "Manchester goods," the head of a family, however poor, was a sort of patriarch, and wielded an absolute monarchy, against which sons and daughters of twenty-five durst not rebel. It was then a source of honour as well as of profit for a man to surround himself with a family of stalwart children. The father certainly spared not the rod, but knocked down sons big enough to have almost eaten him. But this was the general rule; and so nobody thought of opposing it. These were the good old times when tea was half a guinea a pound; and so little were the good people acquainted with it, that it is on record how one old lady boiled her first half-pound, threw the liquor away, and ate the leaves with pepper and salt! She declared, she "thowt na much about it, for o' th' grand folk used it." The morning meal then consisted of oatmeal-porridge and butter-milk, with plenty of both. Was any stomach too delicate or fastidious to dispose of the huge mess?—no matter, the remainder made its appearance at dinner, and again at supper, until devoured from sheer hunger. This was a law strict and universal as those of the Medes and Persians, and from it there was no appeal. The dinner consisted of a huge potato-pie, probably baked in a small washing-mug, with butter-milk to assist its digestion. In the adjoining "loom-house," with which every dwelling was more or less provided, the hand-looms went clitterty-clash the whole live-long day. "A sope o' penky," or small-beer, was allowed on "pot" days—that is, when there was a demand at the warehouses for the work to be in by a certain time. These were the days when St. Monday was duly honoured, and when hatters and weavers celebrated their common saint in festive potations at the village publics; the times when "wakes" were in full swing, and donkey-racing, bull-baiting, wrestling, and footballing passed away the six days in each year which every village kept as its peculiar holiday. Morris-dancers and "rush-carts" —huge wagons decorated with flowers and shrubs —promenaded the neighbourhood, the dancers not unfrequently getting drunk, and leaving their floral display in some ditch. Open house prevailed everywhere ; and people would have gone with half food rather than plenty of home-brewed and roast-beef should be lacking at "wakes" time. The hand-loom weavers and hatters were as fond of fighting as Irishmen; and these were the occasions when long-talked-of battles came off. Many a white-haired out-door pauper, who has outlived his wooden loom, still lingers to tell of the days of his youth, before modern changes had, in his opinion, so greatly altered things for the worse.

" Hatting," or the manufacture of the antiquated beavers, was formerly as great and peculiar a Lancashire trade as weaving, and, like the latter, tended to support patriarchal authority by obliging sons to work together under the supervision of the father. A sort of caste existed in these trades, children invariably following the avocations of their parents for generations. They were brought up to the huge wooden boiler at which the " body-makers " or felt hatters worked, and if too small, were mounted on wooden blocks to enable them to reach the padding table. One window was usually left open for the escape of the steam, and this was the only means of diversion, when the parental eye was engaged, of which the youthful slaves could take advantage. It enabled the more mischievous to shy patches of hot " strickaw," or felt, through at some unfortunate cur, whose loud and sudden yelp told how practised was the marksman in this kind of sport. In every village, from early morning until late at night, the looms rattled and the hatting tables were thumped; the only variations being when some hunting-party passed through, and this, you may be sure, was the signal for all the male population capable of running to turn out. These patriarchal conditions have now been changed to feudal. The factories, like the old baronial castles, have grouped together all the inhabitants. The mill-owner represents the baron, and the shuttle has replaced the spear.

In some districts, as in the neighbourhood of Bolton, we have a mixture of factory and colliery life. The women never think of wearing bonnets except on the Sunday, the entire week passing without them having anything over their heads except shawls. The colliers may be seen squatting along the road-sides like so many Hindoos, this habit having been acquired in the narrow coal passages a quarter of a mile below. As you pass through villages of this description, you must not be too thin-skinned, for factory women and colliers alike are sure to express their opinions about you. Your height, appearance, dress, or anything else will be criticised and turned into ridicule, for they have a keen sense of the ridiculous. In some of the more uncouth districts, indeed, you might once have considered yourself well off if only half a dozen clods whirled past your head!

The colliers are a rough but kindly class. As regards their thorough independence, some of them imagine they can only show it by "purring" the stranger who might offend them in any way. But, at the same time, they are equally as ready to trouble themselves in order to do you a personal favour, and that too in scorn of fee or reward. Supposing you to offer payment for such civilities as being shown some road or another you have inquired about, and offer it to the man who has gone half a mile out of his way to oblige you, most likely his reply would be, "Aw want none o' thy brass!" In every road-side public you enter, if a score of colliers are drinking, you will be proffered a huge stone mug with "Here, sup!" and a refusal would be the most direct way of insulting them. Nothing could be noisier than the company of such men on the occasion of their regaling themselves on the Saturday afternoon —the only time, in winter, except Sunday, when they see daylight. You would expect a fierce fight every minute; but this demonstration only carries off the superfluous energy, and the row ends with a song, in whose chorus every double-bass voice joins, or in some of the company giving a clog dance on the wooden board let into the sandy, flagged floor for the purpose. The tales told of these men's recklessness in times gone by almost make one's blood run cold. It was no uncommon practice, when a collier arrived a minute or two late at the pit's mouth in the morning, for him to leap into the middle of the horrible black gulf down which the cage was fast descending, and catch at the rope with as much ease and coolness as a Londoner would leap on the footstep of a slowly passing omnibus. This recklessness has been much circumscribed since government inspection has been devised; but it still shows itself as a splendid bravery whenever an explosion has taken place. If a coal-pit have peculiar horrors to a stranger when in a safe condition, fancy what it must be after a catastrophe of this sort has occurred, when roof and gallery have been shaken down, and the dreadful "after-damp" has wrapped scores of victims in its deadly folds! For a man to coolly descend a mine between four and five hundred yards deep, up which this insidious enemy has partly crept, and risk his life for the sake of rescuing the mangled bodies of his comrades, indicates a bravery equal to anything that ever won the Victoria Cross. There is none of the excitement of battle to brace the nerves; but instead the agonised cries of a host of half-crazed women and children on the "bank," and a fearful expectancy, making the heart thump against the ribs with a force to unman a giant.

The Lancashire people, not excepting the colliers, are what we should call essentially religious. This has more or less permeated their whole system; and though one hears frightful oaths, we never hear religious matters spoken of blasphemously. Nowhere in England has Methodism taken such strong root as here. Its simple form of worship suits the native character. Among the colliers that peculiar offshoot calling itself Primitive Methodism, but better known here as Ranterism, is the most patronised. To be present at a colliers' prayer-meeting would shock the sensitive ears of Belgravian high-church devotees; but for real earnestness of worship we prefer the former. The speaker who engages in prayer—and these men have so read the one Book that it is a string of rich Scriptural passages, spoken or rather shouted in a clear diapason—is accompanied by his whole audience in a loud commentary of devotional outbursts. It is no uncommon thing to hear such exclamations as the following, for the truthfulness of which we can vouch: "O Lord," said a self-accusing collier, named, as is the custom, after his father and grandfather, "Joan o' Bills,"—"O Lord, wheer should I ha' bin if aw'd never bin converted?" "In hell, Joan!" answered the leader of the meeting; and not a man there but felt the solemn possibility of the remark. The sermons preached by the lay or local preachers are no less commented upon by their ardent hearers, and a young beginner must learn to possess his soul in patience, and be prepared for open expressions of approval or dislike—just as we are told was the custom among the early Christians. It frequently struck us during a recent debate on the deficiency of preaching power in the church, that if our Oxford and Cambridge men were subjected to a test as severe as that applied in many parts of Lancashire to a local preacher, who has to work hard at a trade six days out of the seven, and very likely to sit up all night to prepare his sermon for the Sunday—they would be shorn of those finicking weaknesses which detract from their influence. We were once present at one of these out-of-the-way chapels, when the young preacher was interrupted in his remarks by one of his hearers, an old farm-labourer, who burst out loudly with, " Ay, lad, the Lord's no dumb dogs ; they con o' bark ! "

This religious feeling is thoroughly realistic. The manners and customs of modern life are projected into the regions of the distant East, and time and place completely ignored. We have heard anachronisms sufficiently ludicrous to double one with laughter, and yet the earnestness of speaker and hearers completely prevented even a smile. Many of the local preachers are colliers, and their preaching power is sometimes really marvellous. We have heard the parable of the Prodigal Son explained ; and though the homeless exile was made to soliloquise in the broadest of Lancashire *patois*, we could not help feeling how thoroughly human and homely was that inspired narrative. He was made to compare his wretched condition with his former state, when, according to the speaker, he had a " goold watch i' his pocket, an' a good broadcloth cooat on his back." Then followed the details of his succeeding life—of his old father praying and agonising for him—the whole reaching its climax as given by the preacher: " But aw'll goo whoam agen; aw know my owd fayther will tak me back!" There was hardly a dry eye in the chapel. We shall never forget another occasion, when the manner of the preacher in giving out his text was such that no sermon followed. It was that passage in Jeremiah: "The harvest is passed, the summer is ended, and ye are not saved!" The slow solemn earnestness of the speaker whilst giving out these words had such an effect, that a prayer-meeting took the place of a sermon. In many of the country chapels, at times like this, when the congregation is unusually roused, a " penitent form " is placed, and the startled hearers are waited upon by the leading members, and persuaded to come forth and kneel there. Scenes of this sort leave an impression never to be forgotten. The loud and earnest prayers of the " penitents," the stentorian voice of the individual who is " offering up," for him, the running commentary of phrases from the rest of the congregation, and the sobs and even cries of the affected—these incidents are only to be found in a Lancashire Methodist chapel during a revival service.

Until we approach the Border, the north-western portions of England, and Lancashire in particular, are very poor in antiquities. Tradition, perhaps, makes up for this deficiency; for there is hardly a parish that has not some oral archæology. Something seems to have been known of the County Palatine in the days of the Romans, for one or two "iters," or great roads, passed through it, notably that to York. Antiquaries have recently transferred the Roman name of Manchester to Wigan; and this is an illustration of the fog in which Lancashire ancient history is wrapped. Nobody knows so much of these things as our old friend Charles Hardwick —"th' historian o' Preston," as poor "radical" Bamford called him. The worst (or the best) of it is, if you set him astride his favourite hobby, you had better give up the idea of putting a word in for a couple of hours at the least. Without those means which render archæology a fashionable pursuit among the wealthy, Mr. Hardwick has walked thousands of weary miles, and spent weeks and months in working out the antiquities of Lancashire. How successful he has been is indicated by the fact that from his *ipse dixit* there is no appeal. The Historic Society has done good service in these matters, and obtained more than a local fame. We know little or nothing of the sort of characters the Romans and Normans had to deal with in Lancashire; but we can conscientiously say that, if they were anything like their modern representatives, they had anything but an easy time of it before they conquered them.

To make up for deficiencies in pursuits of this description, the Lancashire people are gifted with an earnest love of Nature, as well as of Music. No other county has produced so many botanists and entomologists. There is hardly a nook or cranny in the shire that has not been visited by the operative naturalists. Poor old Richard Buxton was one of these. He always seemed to realise the description of the wandering "botanist," given by Wordsworth in his *Excursion*. Many a time have we seen his stooping figure slouching along the roads, with a microscopic eye to the "hedge-backings," as they are termed in Lancashire. His only education was at a Sunday school; but he managed to pick up some tolerable Latin, and published a book, the *Botanical Guide*—the *vade mecum* of all Manchester botanists—in which every flowering plant, moss, and lichen within sixteen miles is noted down, its natural history and Linnæan classification given, together with a summary of its medicinal virtues. We never found this little handbook to fail us; yet, we do not believe poor Buxton ever earned a pound a week in his life. He was a "clogger" by trade—a mender of those wooden-soled shoes so much used in Lancashire. A more simply touching and tender bit of autobiography does not exist in our language than in this "brief memoir of the author," which prefaces the *Botanical Guide*. Almost every village has its botanist, or "herbalist" as they are commonly called; for these men often pay the expenses of their natural-history excursions by collecting herbs supposed to possess curative properties, and selling them to the old ladies of the neighbourhood. Lancashire people are as great believers in "yarbs" as old Culpepper himself could have desired. By the way, this book has largely formed the belief, all but universal here, that the herbs should be collected in "planetary hours." Shoemakers or cloggers and weavers are the classes most attached to these out-door pursuits. Their close confinement makes them enjoy the open air all the more; and once a year these operative botanists hold an exhibition of rare or curious plants. It is humble enough in its outer show, being generally held on a Sunday in the large room of some public-house; and there we have met with men who were better acquainted with every detail of floral physiognomy than most gentlemen who write F.L.S. after their names. What is better is to see the love, amounting to almost reverential affection, with which they preserve the habitats of rare plants. The knowledge is communicated with masonic secrecy, and we have known pilgrimages of a dozen miles to be made specially to see how these "were getting on." The establishment of Field-Clubs and Natural History Societies on a large scale was at first a source of continual, and not unreasonable, anxiety to these men. The eagerness of the members to possess herbariums has sometimes nearly destroyed the valued botanical treasures over which generations of working-men naturalists had kept religious guard. The love of horticulture in Lancashire is exceeded nowhere, always allowing for Norfolk; and a patch of cottage-garden, however small, is set apart for the growth of "pot yarbs" or kitchen physic. The late Sir William Hooker was in regular communication with many of the Lancashire muscologists, and more than one species of moss is named by him after their discoverers. The entomologists have obtained no less wide a renown, as all our readers skilled in this science are well aware. The ardour with which these pursuits are engaged in can hardly be understood by those who know nothing of the close confinement of cotton-factories, or the enthusiasm with which the love of Nature inoculates every student. Notably one man we knew, a blacksmith, who in the summer months would leave his work at six in the evening, and walk eight or ten miles to Dunham Park to "sugar" for rare moths; this means plastering certain trees with a composition of honey and attar of roses to attract these insects, after which they are collected by the hunter. The same individual was at his work by six next morning, apparently all the fresher for his night's adventure. Of course, Sunday is the principal day on which these pursuits are followed; for, poor fellows, they have few holidays enough, and one can hardly blame them for zealously studying the

Creator's works on the day conventionally set apart for His worship. On fine Sunday mornings Chat Moss will be seen dotted here and there by scarcely-moving figures, busily engaged in forcing Nature to reveal her hidden treasures. Of late years some excellent geologists have been developed among the working classes—men like John Butterworth of Shaw, near Oldham, whose contributions to fossil botany have found record in the *Transactions* of the Royal Society. Nor are such contributions less valuable because Mr. Butterworth cut and prepared all his sections for the microscope himself, after a hard day's work in the cotton-mill!

As a general means of education, the Sunday schools have been of infinite service to the more densely populated parts of the County Palatine. A quarter of a century ago, they were almost the only, certainly the chief, sources of popular education. Writing and arithmetic were then taught every Sunday morning, and thousands of adults, many of whom have subsequently risen in life, have to thank these institutions for all the education they ever had. This is all over now, for a few puritanical spirits discovered it was sinful to engage in such secular pursuits on the Sabbath; and as a consequence, Sunday-school influence has been considerably weakened among the working-classes. True, other means of instruction have sprung up to take their place, so that now their loss is hardly felt. In spite of this falling away, we do not think Sunday schools are so numerous anywhere in England as they are in Manchester and the surrounding towns and villages. They have exercised a vast social and religious power in neutralising the temptations of such districts. Once a year, in Whit-week, these schools have a three days' carnival. Every town turns out into the country. Trains are run on all the railways so close upon each other's heels, that one wonders more accidents do not occur than is the case. Each train is laden with buoyant, jubilant youngsters, free from the hot factory and stifling foundry, who sniff the fresh air and bask in the bright sunshine like young fawns. The teachers and many of the parents attend on them; and if a stranger were to visit Manchester towards the latter end of this week, he would fancy, from the closed shops and dearth of people, that the city was deserted. Physiologically these outings, which are brief and rare enough, Heaven knows, must be of infinite service to the young in checking or warding off those incipient diseases which hard work and close confinement cannot fail to engender.

When Mr. Barnes popularised the dialects of Dorsetshire, he was little aware that in Bolton a weekly magazine had for years been successfully conducted in the Lancashire dialect. A revival of provincialism has taken place within the last few years; and the Poet Laureate, in his " Lincolnshire

Farmer," has shown how sturdily expressive it may be rendered under a skilful hand. Many years ago, when *Mary Barton* first appeared, the husband of the talented authoress, the Rev. W. Gaskell, prefixed to it a learned essay showing how, when the successive tides of ethnological invasion set in to England from the east and south-east, the waves nearly spent themselves before they reached the north-western districts. Hence we have in the Lancashire vernacular many old British and Saxon words, which Norman rule and speech obliterated elsewhere. We are acquainted with a good many dialects, but it has always seemed to us (allowing for natural predisposition in favour of one's native county) that the Lancashire dialect is more expressive of the ludicrous, as well as capable of being better adapted to the pathetic, than any other. And in this we have a perfect reflex of the people. When two Lancashire men meet after the lapse of years, it seems quite natural, and as though their liking for each other could find vent in no other way, for them to glide into the old *patois*. Recently, such men as Waugh, Brierley, Bealey, and others, have done much to render the dialect popular, even among the upper and educated classes. The reader would find it difficult to produce anything more pathetic on the one hand than the "Come whoam to thi childer an' me;" or a more vivid description of a certain class of Lancashire character than the "Owd Pinder" of the former writer. Brierley's tale of "Jimmy the Jobber" is a splendid example of what power a dialect may possess. Many of Bealey's poems are intensely homely, particularly his "My piece is o' bu' woven eawt." All these men have sprung from the soil, and exercise an immense influence over their fellow-countrymen. Edwin Waugh's songs sell by thousands, and are sung in every town and village, whilst for breadth and wealth of humour, it would hardly be possible to find anything in our literature to surpass such stories as "Besom Ben," the "Barrel Organ," etc.

The Lancashire dialect, notwithstanding its broad vowels and somewhat drawling style, is anything but unmusical in the mouth of a genuine native. Away towards Blackstone Edge you hear it in perfection; but it is necessary to listen to some spreeish tale told in it to understand its power for expressing the broadly humorous. This feature, before mentioned, is one of the most prominent in the personal character of the inhabitants. We do not think the vernacular of any other locality can offer a parallel to that of Lancashire in this respect. Add to it, that the people are many of them full of ready dry humour, and naturally see the funny side of things first, and you may judge how queer some of the dialectic narratives are. A short time ago we were in the neighbourhood of Birtle, three or four miles beyond Bury, and a place well known around for the character of its inhabitants. They are all more or less related, for "th' Birtle lads" allow nobody to go courting the lasses, except those from their own neighbourhood! A friend was with us, and after a few hours' ramble among the hills, the inner man called for refreshment. We entered an old-fashioned public-house, and regaled on such a dish of ham and eggs as you can only get in Lancashire. Talking over the day's occupation, chiefly geological, we were interrupted by a stalwart fellow, who had been quietly smoking and listening meantime, with (for the art of personal introduction is here unknown),

"Aw say, con yo' tell me how *heigh* Adam wur?"

We confessed we had not felt sufficient interest in our first parent to be so far inquisitive; but, to see what was coming, we replied, Quaker fashion,

"Why?"

"Becose," said he, "me an' another chap had a argiment, an' he swore as how Adam wur *forty yard heigh*."

"Well," said my friend, "that's a doubtful question; some say he was forty-one."

The interrogator was not to be put down.

"Ah," said he, "but this chap writ to th' editor o't' London *Times*; an' he sent word as they couldna' tell Adam's height, becose there wur *nobody theer for t' measure him!*"

On another occasion, we were passing along the road, when our companion pointed out a man who was approaching, who, he declared, would be sure to say something original if spoken to. He was a vendor of toffy, which was displayed in a tray carried in front of him.

"Why, Tom," said our friend, "you're spelling 'toffy' with only one *f!*"

"Well, mon," replied he, "it's o' there wur i' th' alphabet; aw took o' there wur!"

Never did the character of the Lancashire people stand forth in nobler relief than during the "cotton famine." We were living in the district at the time, and came into contact with its consequences in such a manner as to have them impressed on memory for life. Never shall we forget the many scenes of patient suffering and quiet misery then witnessed. Much as the country heard of it, these under-currents rarely appeared on the surface. True, England did her duty on that occasion in such a way as to uphold her generous character. We knew whole families to subsist for weeks principally on nettles gathered by the wayside, and afterwards boiled like cabbage, before they surrendered their independence. The disgrace of being "poverty-stricken," as it is termed here, impelled them to put the best side outwards, and not to seek relief until absolutely forced. But most of this had to break down before the iron hand of sheer hunger. If any of our readers chanced at the time to witness the quiet thankfulness of the recipients at the soup-kitchens or sewing-classes, they will still have a good recollection of the strong nature which then endured such a fight of affliction. Entire families of cotton-workers — sons and daughters brought up to the loom and spinning-mule—were forced to remain idle at home, an infliction enough to drive a thorough Lancashire lad almost to despair. One article of furniture or clothing after another found its way to the pawnshops—many of which had to close for want of capital to lend—until hardly anything was left in the house; and then came the bitterness of the sorrow which obliged them to go "to th' guardians" for bread. This dreadful season is still looked back to with horror, for many robust constitutions were then so lowered by want, that they have either fallen away since or are now slowly lingering into premature graves. The personal experience of the "cotton famine" is now told by the winter's fireside, but never a word of complaint against the hardness of the lot is to be heard. The religious temperament of the people came out strongly, and was well illustrated by an incident which happened towards the close of the famine. The mills in one village had been stopped for months, and the first wagon-load of cotton which arrived before they recommenced seemed to the people like the olive-branch, "newly plucked off," which told of the abating waters of the Deluge. The wagon was met by the women, who hysterically laughed and cried and hugged the cotton bales as if they were dear old friends, and then ended by singing that grand old hymn, a great favourite with Lancashire people, "Praise God, from whom all blessings flow!"

Hugh Miller said of Scotland that her Calvinistic tenets had made her inhabitants a thinking people. We believe that the reverence in which the Lancashire people hold the Bible—speaking purely as a matter of cause and effect—has done more than anything else to mould its manly character. It assimilates in its deeper religious tone to that of the sturdy old Puritans; and there would be little difficulty in extending the parallel to more secular features. The business habits of the cities and towns, the rubbing against each other of men in earnest, has strengthened and encouraged the growth of native energy, on the principle of Darwin's theory of "Natural Selection." Hence, whatever the inhabitants of the County Palatine undertake, whether in business, politics, or religion, they do it with all their might.

CHAPTER XIX.

THE STORY OF A RECENT SCARE.

BY the name of "bugs" our Transatlantic cousins denominate all the beetle family. So far they differ in their popular nomenclature from ourselves, who have elevated only one insect to the dignity of the name, and that not a beetle—the too common bed-bug (*Cimex lectularius*) or the *B flat*, as some musical wag has called it. The word "bug" is of Celtic origin, and signifies something terrible, or to be dreaded. As such, its use still lingers in our word "*bug*-bear," and in the more distinctive North Country word "boggart." The allusions to the bug in Shakespeare are not to be understood as referring to this unpleasant bed-fellow, for it had not then made its appearance in England. How the word was narrowed to something dreaded, we have proof in an older translation of the Bible than the authorised one, where, in the passage in Psalm xci. 5, "Thou shall not be afraid of the *terror* by night, etc.," instead of the modern word *terror*, we have *bugge!* Indeed, this insect is believed by some entomologists not to have appeared in this country until after the Great Fire in London in 1666, when a great deal of American timber was imported to rebuild the Metropolis.

When we consider how intricately we are brought into connection, through our commerce, with every country in the world, we cannot be surprised that we should import living insects. Ever since the great scare three years ago, we have been taking precautions against the introduction of the Colorado beetle (which, by the general terror it has inspired, is worthy of the Celtic signification implied in its Yankee name of "Potato-*bug*"); but this insect is almost sure to make its appearance somewhere or another in Great Britain. Whether it will take up its quarters permanently is another matter, as we shall presently see. The wonder is, not that our fauna and flora receive occasional additions from other countries, through our close and frequent relations with them, but that we do not get more. The reasons are not unknown to naturalists, especially in the light thrown upon them by "Darwinism." There are really very few foreign animals or plants which have taken up their abode with us within the last three hundred years. Among the former we may mention the bed-bug and the cockroach (*Blatta orientalis*), which latter, undoubtedly, came to us through Turkey; and in the vicinity of our ovens and kitchens, finds something approaching the hotter and drier climate it was originally brought up to. The American or Canadian weed (*Anacharis alsinastrum*) has been introduced into England, and where the current runs slowly (as in the rivers of East Anglia, and the canals of Midland and Northern England) it has proved a great pest, and almost choked up the streams.

Any one interested in the distribution of animals and plants can see attempted invasions of Great Britain going on every day, although the newspapers take no note of them, except when they threaten to be as serious as that of the Colorado beetle. In the neighbourhood of the ballast-heaps which accumulate about our seaports we may see strange plants springing up, and sometimes blossoming, the seeds having been brought along with the ballast rubbish from distant shores. In the vicinity of cotton-spinning factories in the north of England the cotton-plant has sprung up, and its large canary-coloured flowers may be seen blooming for miles around. In Yorkshire, and also in Gloucestershire, where the Australian and Cape wool is cleansed and worked up, many seeds from Australia and the Cape of Good

Hope get distributed and germinate. No doubt the same kind of thing is going on with exotic animals.

These incidents could be abundantly multiplied, but our object in drawing attention to them is to show that it does not follow, because foreign animals and plants get introduced into this country, they will take up their residence with us. Nay, we do not hesitate to say that the chances must be hundreds, if not thousands to one, against their taking up their abode here. This is proved by the very few species which have gained a recognised foothold within the last three hundred years, notwithstanding the constant invasions. It is not as if England had only just emerged from the sea, and had no native animals and plants on its surface. When an island does emerge, it may be populated with any kinds of animals and plants which can live in the temperature of such island. In England every animal and plant has long ago been more or less adjusted to the physical conditions surrounding it. Both have "brought forth abundantly," and the dry land,—marsh, plain, valley, hill, and mountain-side,—are clothed with plants of every degree of simplicity and complexity. Each common species swarms with *varieties*, the latter having been formed as changes in the environment demanded, so that in this way a constant adjustment has been carried on. It is the same with animals (or rather *was* until man interfered, as he thought for the best—as it has turned out, often for the worst). This "balance of life," when disturbed, lays us open to such external invasions as the much-dreaded one of the Colorado beetle. Happily, we are doing our best to restore it. We have ceased to put a price on the heads of sparrows, although we have much to learn as to what shall be done with our birds of prey. In the case of the common owl, the late Mr. E. Newman used to say every living specimen was worth £5 to the nation, for it destroyed large numbers of mice and young rats, which would otherwise have consumed the grain. But, apart from the mistake we have made in thus interfering with and altering the natural balance of animal life in the British Islands, there can be no doubt it is marvellously well kept up, insomuch that *there is little room for invaders!*

It is on this fact we base our convictions that the Colorado potato-beetle will never obtain such a foot-hold in England as it has in many of the American States. The chances are hundreds to one against its being acclimatised with us as the bed-bug and the American weed have been. Every indigenous beetle would be a natural enemy to it, every bird would be keenly on the look-out for it, and instant to detect such a well-marked and foreign-looking larva. For there can be little doubt that all our insectivorous birds are practical entomologists, and well acquainted with the habits and appearance of all such as usually serve for food. Consequently any newly-imported insect would be detected on account of its strange appearance, and disposed of accordingly. In the first place, therefore, one reason against the Colorado beetle becoming abundant in Great Britain is the fact that we have a long-continued balance of animal and vegetable life, which is decidedly unfavourable to the successful invasion of an insect whose procreative powers demand an abundance of food. Secondly, our numerous wild birds, from the rook to the wren, are so many insectivorous police, guarding us bodily from invasions of this kind. Thirdly, our damp, rainy climate, would, in the case of the Colorado beetle, serve us in good stead. "It is an ill wind which blows nobody good," and here we ought to be thankful for the fickleness of the weather against which we persistently rail! The "Potato bugs" could no more stand our damp and rainy climate than if they were Parisians. Certainly they could not breed here as they do in the United States, where *four broods* are common in the year.

But, it may be asked, how is it that this dreaded beetle has spread over so many States of North America in so short a time? To this we answer that the climate of the United States is of that kind known as *continental*—that is, liable to intense heat in the summer, and extreme cold in the winter. The hot and dry summers favour the beetle's development, and account for its exceptional reproductive powers. Again, the entire area of the United States has had its organic balance dreadfully upset since colonisation set in. Forests have been cut down, marsh lands drained, large cities and towns erected ; entire groups of animals and plants have become locally extinct, or extinct altogether. Moreover, the early colonists shared the prejudices of Englishmen, and shot off all the small birds they could. Within the last few years, both there and in Australia, they have been importing English sparrows—that most fecund and "cheeky" of the feathered tribe! It is in consequence of this organic disturbance of the balance of life in America that agriculturists are so exposed to the sudden ravages of insects. Those of the "potato-bug" are only one among many. In 1877 there was a plague of "locusts," or grasshoppers, against whose ravages prayers were offered up in the churches and chapels!

Thus the dry summers of the States, combined with the general dearth of insectivorous birds, and the disturbance of nature's physical balance, have rendered it comparatively easy for insects, possessing such extraordinary reproductive powers as the Colorado beetle, to spread in every direction and displace other insects less injurious. But these very reasons render it very unlikely that this beetle will succeed in being so costly to us in England. On the Continent, it appeared at Mulheim, a few miles from Cologne, where in the summer of 1877 we saw several fields of potatoes in which it had taken up its abode. It is much more likely to spread in Germany than in England, on account of Germany having a continental climate—that is, hot and dry summers, which would favour the beetle's development. On the other hand, the German Government are protecting their small birds even more than we are, and to rob a bird's nest even of its eggs is penal; so that the Colorado beetle, in spite of the dry summers of Germany, will have more foes to contend with in the shape of insectivorous birds than it has been accustomed to. The fact that no further results have ensued from the appearance of the potato beetle at Mulheim, prove how effective are the natural ornithological agents against its propagation.

The spread of the Colorado potato beetle (*Doryphora decemlineata*) is a matter of history. It was first discovered and described as a very handsome beetle (which it certainly is) in 1824, when it was found in the Rocky Mountains region of Missouri. At that time it was found feeding on a wild species of potato, for it is not particular to one species. As the country west became more settled upon, and crops of various kinds were planted in the clearings, the squatters came into painful experience of what was to them a veritable "bug," or something to be afraid of. The potato is one of the food plants which, we may be sure, will accompany the adventurous wanderings of the white settler. Accordingly, when the potato crops spread westerly, the potato beetle welcomed them; and showed such a preference for the cultivated kinds of *Solanum* that it deserted every other for it. It did not wait for the potato-planting to be extended *westerly*, after having tasted blood, but commenced spreading itself *easterly* in order to get where the potatoes were growing even more abundantly. In 1859 the beetle had migrated easterly as far as Nebraska, in 1861 to Iowa, in 1866 to Wisconsin and Illinois, in 1868 to Indiana, and since to all the countries on the Atlantic sea-board. When it reached New York it began spreading north and south, until it eventually reached Canada at one extremity, and nearly to Florida on the other. Since 1859 this beetle has spread over one-third of the entire area of the United States. The value of the crops destroyed in this period reaches almost a fabulous amount, so there is every allowance to be made for the "scare" it has caused among our Yankee neighbours; and equally so for the "terror" it created in England and Germany during the summer of 1877.

It is not the beetle, however, which is so destructive, but the larvæ or young. When the insect has reached the beetle stage, all the harm is done. The eggs are laid on the *under* surface of the potato leaves —a dodge, this, on the part of the beetle, for the eggs are protected thus from the heat of the sun, as well as from the eyes of birds. The eggs are soon hatched, and the young grubs commence feeding voraciously, changing their skins often, and devouring all the leaves down to the haulm. No potatoes can grow, no tubers can be formed, for the plant is destroyed before the tuber has commenced; so that the idea is erroneous about the potato beetle feeding on potatoes. The fact that, under favourable conditions, this beetle will lay four sets of eggs in one season, and that the progeny from a single pair of beetles, if undisturbed, would number 14,000 at the end of the season, is quite sufficient to account for the disappearance of miles upon miles of the potato plants.

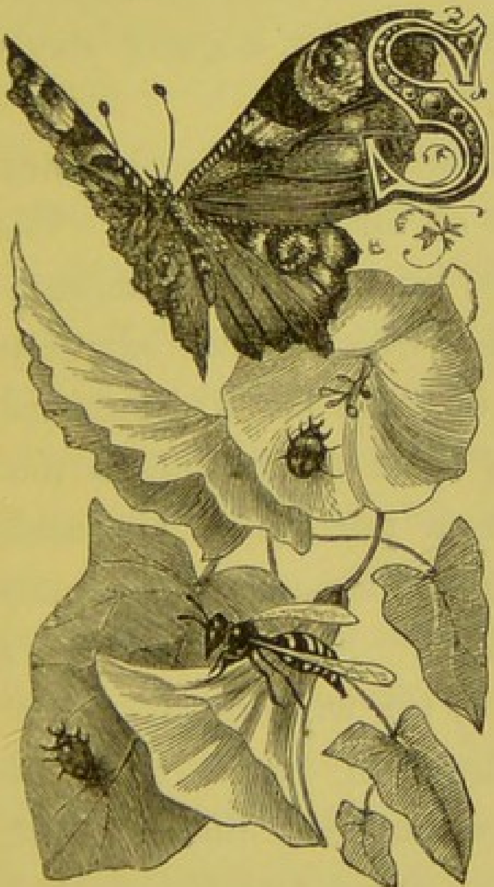
As in many other instances where some knowledge of natural history is required (in the United States a knowledge of the beneficial and noxious insects is deemed so valuable that a State Entomologist is salaried by the country), we had many ludicrous mistakes made in England during the last summer or two as to the identity of the potato bug. The most delightful of them was the pathetic description which appeared in one of the Central Press telegrams, of a poor Colorado beetle having been caught clinging by one leg to a mooring-rope which hung down to the water along one of the Dublin quays! The affecting position of the curious insect stranger, in the very land of "praties," could not have been more comical if it had been intended; and an old newspaper writer can sympathise with the reporter who forwarded the above telegram, when he had to reply some days later that the half-drowned insect was only a ladybird after all! Descriptions of every stage in the life-history of the Colorado beetle have been haunting us during the last three years. It is not many months ago since it was gravely stated in the papers that a potato beetle had been found *inside* a potato at Cardiff! The insect turned up at the British Association meeting at Plymouth in 1877, where it was suddenly metamorphosed into a "lion."

At the above-mentioned meeting Mr. M'Lachlan, one of our best entomologists, declared his opinion that the English climate and organic surroundings were decidedly against the potato beetle gaining that ground and spreading over the United Kingdom which had been feared. Mr. E. C. Rye, the celebrated coleopterist, also thinks our cold and damp climate would prove antagonistic to it, especially as the potato beetle belongs to a group which has its head-quarters in tropical America. A good deal of nonsense has been talked about a certain parasite on this beetle, which parasite (the newspapers said) had a kind of very hard horn, by means of which it bored the Colorado to death! It is no unusual thing to "be bored to death," and we therefore deeply sympathise with the potato beetle in this case. One can only wish that the writers of such paragraphs knew a little about what they wrote on such matters. It would save a world of anxiety, although naturalists would be deprived of the pleasure of a hearty good laugh! The cures for the spread of the potato beetle have been as ludicrous, from a chemical point of view, as the account of the habits of the insect from that of newspaper zoology. In many instances the destruction of the beetle would, if thus carried out, be greatly more expensive than its ravages; in others, the recommendations were simply absurd, or at least not a bit more cunning than the recipe of the Lancashire weaver for slaughtering bed-bugs—"he always killed 'em wi' a hommer!"

At the same time, it behoves us to be watchful, and *intelligently* watchful, against the appearance of this pest. The beetles should be systematically hunted for in spring, before they have laid their eggs, and if found destroyed. It is said the American agriculturists found that a solution of Paris-green in water is the most effectual destroyer of the larvæ. This solution is sprinkled by a machine over the plants; and the occasion has developed Yankee mechanical ingenuity in many forms, so that the reader has now more than one kind of "bug-sprinkler" to choose from.

CHAPTER XX.

PIKE-FISHING IN NORFOLK.



SCOTLAND may reasonably boast of its salmon, although it is no longer so abundant that the farm-labourers stipulate they shall not eat it more than thrice a week! Alas, this "king of fishes" has become nearly extinct in many places in England where, a century or two ago, it was almost equally common. The law has cast its shield over it; and by dint of "close seasons," expensive keepers, artificial ladders, etc., we manage to secure salmon enough for the angling delectation of a score or two of gentlemen, who have patience sufficient to follow it under the idea of sport. Trout-fishing is considerably better; although, thanks to our manufacturers, who seem to consider streams pretty much in the same spirit that Brindley regarded rivers—as a natural means by which they can get rid of their waste—there are few of our rivers which are not more or less poisoned. It requires both time and skill to secure a decent creel in these degenerate days. Indeed, so rare is the occurrence of incidents which were deemed common enough half a century ago, that we must needs chronicle it in special sporting papers whenever an angler has a good day's sport.

Thank Heaven, this wholesale destruction has not yet extended to every part of Great Britain. We have in the eastern counties, but more particularly in Norfolk, tracts of country which have scarcely been altered by the hand of man for a thousand years. The flattest part of that country—so flat that it might be regarded as a portion of Holland, which had broken off and drifted across the German Ocean—is a district *sui generis*. Some of its rivers (and there are many of them) go winding for sixty or seventy miles, before they can reach a point which might be traversed, as the crow flies, in nine or ten. Every now and then these streams flatten out into the great shallow pools or lakes, vernacularly termed "Broads," to which we have already drawn attention. Some of these Broads are several miles in circumference. The intervening areas are often very much like Milton's "boggy Syrtis," neither "sea nor good dry land." Within the modern days of agricultural science such parts have been drained, so that "dykes" or ditches a dozen feet across connect the rivers and the broads. It will readily be imagined that such circumstances must be exceedingly favourable to fish-preservation. The bream come rolling like waves from the rivers into the broads, for the purpose of spawning. Roach, perch, and "rudd" are scarcely less plentiful. No manufactories turn their filth into these immense bodies of fresh water; and though the means of obtaining fish be somewhat primitive, and perhaps, in the estimation of "anglers' societies," illegal, we doubt whether they do more harm than good.

Norfolk is the paradise of the pike. We may read in the newspapers of his growing to an enormous size in some solitary fish-pond, where for aught we know, and if the stories of his longevity be true, he may have reigned supreme since the days when the pre-Elizabethan monks placed him there as a young pikerel. But nowhere does the average size of pike equal their condition in the Norfolk rivers and broads. There you find them in all ages and sizes—from the three-inch jack just trying his "prentice han'" upon equally juvenile roach and dace, to the still growing elderly individuals over three feet long. Their number is legion; and Norfolk pike-fishing, in our estimation, equals trout and salmon-fishing for right-down good sport. If you are inclined to be sentimental, and to subscribe to Mr. Freeman's views about hunting, you have the satisfaction of knowing, when pike-fishing, that you have not lured poor herbivorous creatures to their destruction, but simply caught the carnivorous cannibal that intended to do unto others what you intend to do unto him. Of course, abundant though this tyrant of the fresh water is in the places we have mentioned, there are times and seasons when you may try your luck, and try it in vain. You must consider time and tide, in the most literal sense, if you desire to be successful. An easterly wind will not only keep the pike, but every other fish, quiet at the bottom, or nestling in the reeds. A few days of rain will muddy the water, and thus prevent the pike from seeing a bait, even if it were illuminated by the electric light. Then, as regards the tide: this is an important item to be studied in Norfolk pike-fishing. We have mentioned how flat the country is in the "Broad district"—so flat that rivers have not a fall of many inches in scores of miles. The consequence is that an unusual tide—as when the north-westerly gales have been blowing—will find its way up the rivers, broads, and dykes, turning the water brackish, and either driving the more delicate fish before it, or turning them up sick and dying. The pike, as well as the roach, is very susceptible of salt water, and, burly though he be, cannot stand it at all; whilst the bream and the perch seem to revel in it, if it be not over saline. These periodical salt-water inundations, we have no hesitation in saying, destroy more pike than anything else. If you were then to go up the "lanes" leading from the rivers to the broads—so called because cut out of the tall stems of *Arundo phragmites*, the grass used for thatching—you would see scores of pike turned up and floating on either side. How many find their way into the thickets of tall reeds and grasses, we cannot say; but, considering that a greater portion of the watery area is covered by these than is left uncovered, the number seeking shelter or driven there must be immense. And yet these periodical thinnings do not seem to have decreased the number of fish. The multiplication of dykes has given them increased facilities for spawning; whilst there need be little fear of their not obtaining food sufficient and to spare, as long as the waters yield such quantities of roach, dace, bream, and eels.

We know nothing that tends more to brace a man's nerves than a day's pike-fishing on these Norfolk rivers, during such weather as that we may expect to enjoy during October, when the air is as soft and balmy as nectar. You drive to such a place, say, as Horning Ferry, where you find one of the old-fashioned angling-houses whose cleanliness and good cooking would have delighted the heart of ancient Izaac Walton. Your route has lain through a few miles of the most picturesque road, lined with thick woods, where the occasional popping of guns tells you the shooting season is on. After arriving at your destination, you set out in a flat-bottomed boat, hired for the day at the modest rate of sixpence. If you have permission to angle on some of the more private broads, you may reasonably anticipate excellent sport. As before mentioned, through some of the larger of these sheets of water the rivers run, whilst others are connected with them by broader dykes than usual. The Broads which rejoice under the latter circumstances are naturally better stocked with fish, and as many of them lie within the enclosure of private estates they are better protected. Your day's sport will be rendered more probable if you engage the services of some brawny marshman to row you. These hardy, weather-beaten fellows are ardent naturalists, and know almost every bird and beast they come across, although they are not able perhaps to give them their Linnæan names. Even supposing the weather or the tide spoil your sport, such a man will entertain you with old-world stories of the mighty fish at whose death he has "assisted," or will give you lists of birds which you imagined had long ago been expelled from merry England. You take your seat in the *bows* of the boat—it is a great mistake to sit behind and spin, as we shall presently point out. The October sun shines warmly, and lights up the quaint water-mills which make this part of the country look so much like Holland, or warms more intensely the tan-coloured sail of some distant barge. Gently, but impelled by a strong and steady hand, you glide past thickets of tall grass, whose dried-up panicles make melancholy music as they rustle in the wind. An ancient heron or a flock of wild duck occasionally cross your path, or your attention is drawn by your companion to the coot and water-hens you may see sporting on the surface as you turn some sudden corner. Their quick eyes have detected you, and all that remains of them to the visible sight are the long ripples left by their trailing legs. This perhaps is the place recommended by your boatman. Standing in the bows, whilst he gently keeps the boat steady, rowing towards you, you commence making "casts" with your dead bait, first on one side and then on the other, so as to completely work all the water. This plan is much better and more scientific than that of trailing dead bait or artificial minnows behind the boat, especially in shallow water. Owing to the boat going first, in the latter plan, the pike are scared away, whereas with the former you are likely to come on them long before you disturb them. A few casts are made, when suddenly you feel as if your hooks had caught some waterlogged plank. Steady, and keep a taut line! The pike slowly rises; for it takes a few minutes for him to realise the fact that it is *he* who is caught, and not some delicate morsel, as he had imagined. He soon finds his mistake out, and the slow rolling is immediately changed to a rapid rush here and there, which tries both your skill and nerve. Here the valuable services of your partner come into action. He " puts you about," as they term it in Norfolk, and makes the boat to follow the frantic movements of the jack. Five or ten minutes' play tells upon him. He begins to lie helplessly on the surface of the water, and only rushes off again when he sees you attempting to secure him. A few minutes more, and the violence of his unusual exercise renders him entirely helpless. He submits to be hauled close to the boat's side, when your companion drags him in, by seizing him in the orbits of the eyes. No sooner does he find himself in a more attenuated element than he commences plunging and snapping. Again he is seized and held down, a gentle tap on his shark-like skull, or the passing of a penknife-blade through its sutures down to the brain, gives him his quietus. There is a tremulous quivering of the tail, and all is over. You lift him up, to find a handsome, healthy jack, of some eight or ten pounds.

It is not at all an uncommon thing for a skilful pike-fisher to take from a dozen to eighteen fish, of various sizes, in the manner above mentioned. A more profitable way of obtaining them, however, and one which—in spite of what those gentlemen may say who strive to elevate angling into one of the fine arts—is not without its zest, is that known in Norfolk as " liggering " and " trimming." The latter method is the more interesting. To indulge in this—and it is more frequently indulged in than the orthodox fashion—it is necessary to take with you a supply of live bait and a number of round wooden objects, not unlike the wheels of a child's go-cart. These are the "trimmers" in question. The edge of the wheel-like article is fluted, and round it are wrapped a score or so of yards of twine, one end of which is fastened to the "trimmer." At the other end is the deadly pike-hook, whipped to wire. The wire is passed under the skin of the live bait, in such a way as not to injure it, and the large hook drawn close to its body. The cord is then wound round the edge of the "trimmer," and passed over a slit on the top, so that seven or eight feet hangs in the water, with the fish terminating it. This apparatus is gently placed in the midst of the river, or in the deeper and clearer parts of the broad. The poor bait, finding himself in his natural element, sets off on a frightened voyage of discovery, dragging the floating "trimmer" after him. It will not be long ere some adult pike or juvenile jack, on the look-out for what may "turn up," hails the sight of a strange fish in difficulties. He slowly swims round him, and his terrible gaze frightens the poor roach into sad vagaries, all of which are evidently as much enjoyed by the pike as the frantic struggles of a mouse are by a cat. It is a singular fact that pike will always take roach or dace from other waters in preference to those of their own; and this weakness of theirs is so well known, that Norfolk fishermen usually take their live bait with them, although it might so easily be obtained where they are going to by a cast-net.

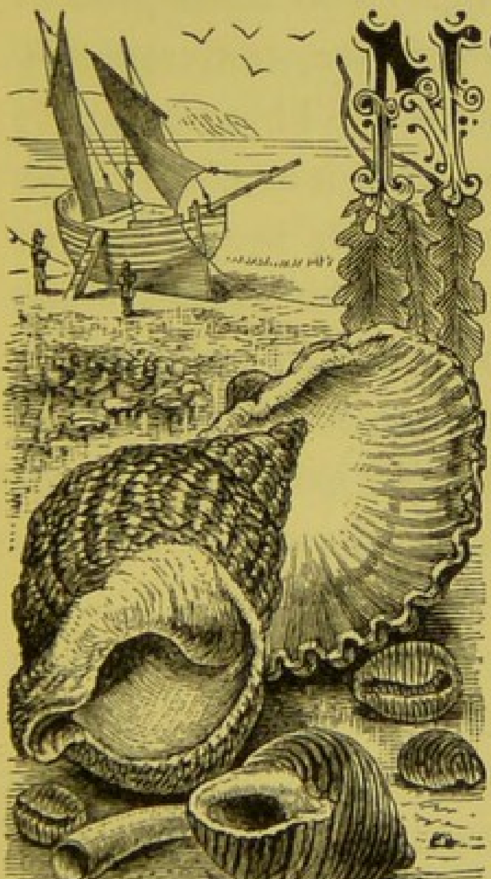
Another fact in the natural history of the pike is, that he will always seize the weaker among the finny tribe, and you will generally find him lying in those parts of the stream where the eddy is sure to whirl some ailing roach or perch towards his voracious maw. It is this habit, we imagine, which makes "trimming" or "liggering" so destructive where there are pike. However, to return to our original bait: it is at length seized by his enemy, who bolts him head foremost. But a new sensation has seized the monster. There is a prickly stinging feeling in his palate, which causes him to swirl his tail, and rush away. It is his turn now to pull the floating machine after him, and, as he does so, he so twitches the cord as to turn the "trimmer" over, and thus to enable him to run off the line to its full length. Perhaps, by the time he has done this, he may have suddenly stopped, to strike off again even more swiftly when he finds his motions impeded by some obstacle to which he is attached. We will suppose you have been, meantime, dropping a score or two of "trimmers" into the river or broad. Each "trimmer" is painted red on its upper side, and white on its under, so that the moment a pike has struck, you can tell by the difference in colour. It may be that, as you are slowly rowing about, looking after your flotilla of infernal machines, you suddenly see one of the red discs changed into a white one. You row up to it, and startle the trapped pike so that he darts up the river, trailing his bonds behind him, and giving you a stern chase of a hundred yards or so. At length you reach the "trimmer," haul in the line, letting your fish play meantime; for there is no knowing the extent to which he may be hooked, and we have seen many a fine pike bow a sudden farewell to his intending captor when within a few inches of the boat. Generally speaking, however, when the sport is decent, the pike will run themselves down, so that they lie helplessly enough when you row up to them. The quantity of pike thus obtained, when the wind, tide, and weather are favourable, is almost incredible. The largest fish, also, are usually taken in this way.

We have already referred to "liggering," which is based much on the same principle as "trimming"—or, as our angling authorities would say, on the same want of it. It is, however, more humble in its character, and generally adopted by the villager with a poaching proclivity, and whose pocket is too slenderly lined to admit the purchase of the necessary tackling for "trimming." All he requires is a pennyworth of cord, and a double pike-hook fastened to a twisted wire. The latter is made secure to the cord, after having been passed beneath the skin of the live bait, in the manner above mentioned. Furnished with this, he makes his way to some deep hole in the stream or river, where he has seen a large pike sunning himself. These fish have a peculiar fondness for one spot, and it is not unfrequent for the largest pike, male and female, to tenant the deepest and most promising holes. When you have had the luck to take such a pair, you will generally find that a brace of pike, a size smaller, will take up their abode in the vacated habitat. It is in such a hole that the villager places his "ligger." About two or three feet above the live bait is fastened a large perforated bullet, and the poor roach is thrown into the water thus, the other end of the line being made fast to a peg driven into the ground, or to the stems of the tall grasses which grow along the margin of the stream. Anchored by the weight, the bait can only revolve in useless struggles, its glistening sides reflecting the light, and attracting the pike not far off, who has been regarding the unusual splash with some degree of suspicion. The temptation, however, is too great for him, and the bait is bolted, with the same fate to himself as if he had patronised a "trimmer" instead. The village pike-poacher usually lays in his ligger over-night, perfectly certain that, when he rises early next morning, there will be a decent jack for his dinner, if he can only get it away without the keeper's detection.

There is yet another way of taking pike, which, although we have occasionally indulged in it from motives of curiosity, we must condemn. One must draw the line between legality and illegality somewhere, and so, for classification's sake, we draw it here. The pike come up the dykes during March and in the beginning of April to spawn, the females coming first, and the males following them in order to milt. During this season, we may see the village mind intent on "snaring" the too-confiding fish. Armed with a long hazel rod, to which is suspended about a foot of cord and another foot of thin copper wire, twisted into a running noose, the rural poacher rambles down to the water-side. He walks along the bank until his eye detects some pike, either sunning himself, or engaged in the most important occupation of the year. Keeping away from the bank, the rustic walks a few yards up-stream, and then gently lets the copper noose into the water, moving towards the unsuspecting fish until the noose is allowed to pass over his head unconsciously. Now is the time! With a steady but sudden jerk, the noose is tightened round the fish's body, and the prey is dragged ashore. Some splendid pike are taken in this way, and, as we have confessed our own sins, we can afford to condemn a practice which destroys a fish full of spawn. It requires no little skill and no little steadiness, both of eye and hand, thus to offend. From April to October, the pike have a "close time" of it, except when some snare is skilful enough to capture them in the summer time—a thing not always done, although often attempted. You see the "liggering" season is coming on, for occasionally while angling after more modest sport, when you have struck a roach, and are playing with it, some eager jack will seize it, and you have the pleasure of having two fishes to your line. You may, perhaps, be able to haul victim and captor to the river bank, but the latter is sure not to wait for a farther introduction, but will bolt off, leaving your mangled roach to tell of his voracity. As before remarked, there is sufficient zest about legitimate pike-fishing in Norfolk, and sport enough to make it interesting to a man who has been toiling at the desk for a twelvemonth.

CHAPTER XXI.

AQUATIC ENGINEERS.



NOTHING perhaps strikes the reverent student of natural history more thoughtfully than the special adaptations of certain creatures to distinct habits of life. They are so numerous that his studies are beset by them at every step. To him it is overwhelming proof of Creational wisdom and goodness, for by this specialisation animal structures attain the highest degree of mechanism, and brute intelligence soars to its loftiest flights.

The Beaver offers us such an example of mental and animal adaptation as we here speak of; and in it the principle is perhaps more interestingly developed, on account of the evident manner in which its application varies in degree, according as circumstances may require. This animal has not the high geological antiquity which many tribes of animals can unquestionably claim. Its remains have been met with in strata of the same period, both in Europe and America, in that known as the *Miocene.* The American fossil beaver is called *Palæocaster.* It was much smaller in size than its existing representative of which we propose speaking. The most ancient European beaver was the *Stereofiber*, contemporary with the American extinct species. This afterwards gave place to one much larger, known as the *Trogontherium*, whose remains are met with in the ancient Fossil Forest we have already described, which crops out from beneath the steep Norfolk cliffs at Cromer. The *Trogontherium* was about one-third bigger than the common living Beaver, but its habits of life appear to have been very similar to those of the European species.

The latter is believed by all naturalists to be a distinct species from the American animal. Externally there seems to be no distinction worthy of note sufficient to place the two animals in different species. In the structure of the bones of the head, however, and especially of those of the nose and upper jaw, there is a marked difference. Whether it is sufficient to merit their specific separation is another matter. Certainly we know of no other two species of animals which approach each other so nearly. To us the difference seems to be one of geographical separation rather than anything else. At the same time it should be noted, that the habits of the European and the American species differ in some degree. The former do not habitually build the famous dams and huts, which the latter are so well known for, and in the construction of which they show such a degree of ingenuity and sagacity that we do not hesitate to call them "Aquatic Engineers." Formerly it was thought that the European Beavers did not erect dams at all; but this has been disproved, although there is no doubt the habit is an exception rather than the rule. Both species cut down young or small trees, and in the European Beaver this habit appears to be more the inherited recollection of a former condition than to be required by modern necessity. Again, we find that the dam-erecting and hut-building propensities of the American Beavers differ in degree. Sometimes they are not exercised, and the Beavers content themselves with living in holes burrowed in the banks of streams, something after the habit of their first-cousins the water-voles. It is possible, therefore, even in this series of differences, to perceive how the old world and the new world Beavers may be brought more nearly into relationship.

Formerly the European Beaver was very abundant, and had an extensive geographical distribution. Its decrease in numbers and extinction in localities appears to be in proportion to the spread of population and the development of civilisation. The Beaver loves solitary rivers and streams. As man becomes civilised he requires those rivers to sail his vessels upon, and their currents to turn his mills with. The Beaver, therefore, must retire. Perhaps the soft, silky, warm fur of the animal has caused it frequently to disappear more suddenly than it otherwise would have done. Once it ranged all over Europe, from Sweden and Norway to the Black Sea ; and from the western coast of France to the Ural mountains and the Amoor. Now it exists on sufferance, or in those few wild and desolate spots—as on the streams flowing from the Ural Mountains and in those emptying themselves in the Caspian—where man has not yet set up a claim of ownership or requirement. These are the only natural habitats left to this poor hunted-down animal. Along some parts of the Danube the European Beaver may still be found ; but it is owing chiefly to the kindness of the Emperor of Austria, who preserves it in one of his parks. In Norway the last Beaver was captured in 1844. They lived in hosts in the Fen country of England before the period of written history commenced ; and their bones, skulls, and teeth are found in great abundance in the peat marl which underlies many parts of the Cambridgeshire and Norfolk fens. A few years ago a few Beavers were introduced by the (now) Lord Waveney into his park near Beccles, in Suffolk, through which the river Waveney flows. They were soon removed, however, owing to the harm they did the trees, and the speedy way in which they threatened to interfere with the river drainage. We saw the bases of two trees, one of at least a foot diameter, which had been gnawed in sunder by the chisel-shaped teeth of these Beavers. No woodman's repeated blows of axe could have been more effective in severing the trunk from its base than had been the quiet and persistent incisors of these diminutive animals! How abundant the Beaver was in Great Britain in former times is still indicated by the names of several localities. Thus, Beverley, in Yorkshire, is said to owe its name to the former presence of Beavers. In North Wales, we have Nant Francon (the "Vale of Beavers"), near Capel Curig; and any one who knows that spot, and is acquainted with the habits of the animals in question, will acknowledge that its geographical position is just such as would be selected by them.

Beavers appear to have existed in tolerable abundance in North Wales and some parts of Scotland, as late as the reign of Henry II. That careful but gossipy observer, named Giraldus Cambrensis, states, that in his time they were abounding in the Teifi lake and river (no place more likely for them). In the ancient Welsh laws of Hywel Dda, the Beaver was especially mentioned. This was about the year 930 of our era. Remains of these animals have been found in the neighbourhood of many of our chief

English rivers, among others in that of the Thames. Perhaps their habits were different in these early times, and approximated more nearly in their instincts towards those of their American brethren than they have done since.

The American Beaver is now having a fine time of it. It once had a much wider geographical range over the new world than it now enjoys; for the enormous development of human population has of course rendered it impossible for this solitude-loving animal to frequent the same districts. It is now rarely found east of the Missouri river; although it once ranged from the most easterly to the most westerly point of the American continent, and in the other direction, from Labrador to New Mexico. No other American animal has suffered so much from the hands of the hunter and trapper as the Beaver. Some of our readers may remember the time when "beaver hats" were the rage among well-to-do Englishmen. This was in the days before "silk" hats were thought of. European fashion affected that style of hat, and the Beaver was hunted down to satisfy it. The Hudson's Bay Company then imported no fewer than *eighty thousand* Beaver skins in one year into Great Britain alone! The ease with which the fur could be *felted* was their chief recommendation. But the introduction of "silk" hats came, most opportunely for the American Beaver, otherwise it would by this time have been hunted to utter extinction. Whereas their skins, thirty years ago, were worth half-a-guinea each, they now fetch but a few shillings! The consequence is that Beaver-trapping, to which many men devoted themselves more than a quarter of a century ago, no longer pays, and is practically given up. The Beavers, like all other rodents, are animals which multiply very rapidly, and so we find they are fast taking up their old positions on the lakes, rivers, and creeks of North America, where quiet and solitude still reign supreme.

Our readers have doubtless heard of the rapidity with which Beavers can cut down trees. Before speaking as to the reason for this, it will be worth our while to note the peculiar structure of the tools with which the Beaver works. These are its teeth. The two incisors, or "cutting teeth," in the upper and lower jaws are very largely developed. The teeth which are usually placed next to them in other animals (the "canines") are absent; so that we can see how arrangements are thus made for the enormous growth of the incisor teeth. These are long and curved, and are only covered with hard enamel in front, the sides and hinder parts being unprotected. It follows, therefore, that the hinder part wears away soonest, and thus a sharp chisel-like edge is always kept on the front enamelled portion. These chisel-shaped incisor teeth are supplied with persistent pulps, so that they grow during the whole life of the Beaver, and it thus becomes imperatively necessary that it shall gnaw in order to prevent the growth from being a nuisance and an evil. This is one reason why rats and mice gnaw so much, and not because they are always seeking food. The manner in which the lower jaw is jointed on to the skull, so as to allow the to-and-fro movement we call gnawing or nibbling, is peculiar to the rodents as an order. In the carnivorous animals the movement is up and down, like that of a pair of scissors, and is especially adapted for cutting. In the herbivorous animals generally it is sideways, or has a rolling, mill kind of motion, as in oxen and sheep. In the Beaver family it is the motion we give to a rasp or a file when we are using it. The muscles attaching and working the jaws have to be fixed in different positions, according as the above movements are required.

A good deal has yet to be written about the *tails* of animals. No other organ is so largely adapted to different requirements in animals. In some it serves as a tripod, as in the kangaroos; in the American monkeys it is prehensile and possesses all the tactility of a hand; in the fishes and amphibious it is a propelling screw for locomotive purposes; in many birds a personal ornament—the peacocks and pheasants to wit. Undoubtedly the old notion that the Beaver used its horizontally-flattened tail (denuded of hair like that of a rat), as a sort of trowel, is not true to the extent it was once imagined. But there seems no reason to question that the tail is used to give the last finishing stroke to the mud which it plasters over the twigs, stones, and mud which build up the walls of its lodge or hut.

The Beavers prove themselves to be aquatic engineers in the way in which they contract the dam or weir across the streams they frequent. During the summer even the American Beavers lead solitary lives,—we see nothing of dam-building or hut-making at that time. Just before the leaves begin to fall is their "busy time." The animals then collect in numbers, and combine to form their winter colony of huts. These are of various size, according to the number of tenants they are to house. The smallest and simplest are six or seven feet high, circular in plan, and about three feet in diameter. Such an one would hold from three to five tenants. Others are larger, and are in fact a sort of Beaver barracks. If possible, all have dykes or moats running round them, filled with water; for Beavers are poor travellers on land, and always prefer taking to the water if possible. The huts or barracks are double-roomed, the upper being dry, and the lower communicating with the water both by the means of admission and exit. The walls of the house are built first of boughs and twigs, filled in with pebbles, and compacted with mud. They are so strong that the powerful claws of the *Wolverine* (one of the Beaver's sworn foes) cannot tear them down. As soon as an enemy attacks the dwelling, the inmates quietly retreat to their aquatic chamber, and so escape. Not unfrequently as many as two or three hundred Beavers will associate in one colony, and then the river banks form a lively scene. All combine to construct the dam which arrests the flow of the river or stream. If the current be slow and weak, the dam thrown across will be carried in a straight line. Here it is that the engineering instincts of the Beaver are most remarkably exhibited. A straight dam is the weakest, from a mechanical point of view, and this kind is only used in shallow or weak currents, where no other kind is required. But in rivers where the currents are powerful, such an obstacle would be carried away immediately. Under such circumstances, therefore, we find the Beaver erecting a bow-shaped dam, with the convex side towards the current. This is the strongest plan that could be devised, and little or no additional materials are required. The reader will remember that in cataracts or waterfalls (that of Niagara, for instance), the platform over which the volume of water tumbles is shaped like a horse-shoe. We see, therefore, that the mere *shape* of a structure has largely to do with the mechanic resistance to pressure or force. The Beavers are not only well aware of this fact, but we find that the curvature of their dam varies in proportion to the strength of the current it is opposed to.

In the construction of this dam, also, considerable engineering ingenuity is shown. The reader has seen a sea-wall, thickest at the base and thinnest at the top. This is the principle adopted by Beavers. The thickness of the dam varies from a diameter of twelve feet at the bottom to two feet at the top. It is first all planned with rough logs, then come boughs of trees, stones, and mud. The latter is carried in the fore-paws of the animals, handfuls at a time. Their industry is truly marvellous; and the work, although done entirely by night, increases with a rapidity which seems to have quite astonished all actual observers. In order to cut down the numerous trees and boughs to be used in these architectural and engineering operations, the chisel-shaped teeth are brought into use. The Beaver sits on its hind quarters, and gnaws at the tree at the level of its own head. It gnaws the trunk all round, much after the fashion with which a wood-cutter hacks at a tree he wishes to fell. Like the wood-cutter, also, the Beaver works most on the side towards which it wishes the tree to fall. As soon as the tree is down, assistance is rendered by its companions in cutting off the boughs, or in carrying the tree away piece-meal to be used for the engineering purposes above mentioned.

The wonder is to find such ingenuity exercised for so small a purpose. The dams thus erected last for years, and not unfrequently the wood, of which they are largely composed, sprouts, so that a fringe of living vegetation marks its position. The houses or huts are annually repaired for winter use, so that the principle of economy of labour is also studied by these patient and harmless little animals. One hardly knows which most to admire—the Wisdom which works in them and by them—or the perfection by which that wisdom adapts otherwise feebly organised animals to such special conditions of life!

CHAPTER XXII.

VEGETABLE PARASITES.

FEW people possessed of even high intelligence are aware of the vast number of vegetable parasites which exist around us. They are chiefly microscopic in size, and are popularly grouped under the common name of "moulds" and "mildews." The housewife knows a little about them to her cost, for she finds them turning her catsup ropy, and taking possession of her preserve jars; much to her discomfiture she finds a thick stratum of bluish-green mould covering the surface of the fruit she took such pains with, and which she was about to exhibit before the admiring eyes of sympathetic friends. The farmer knows too much about them, under the names of "rust," "bunt," "pepper-brand," "bladder-brand," "smut," "mildew," and "potato disease." The gourmand encourages their growth on his fine old Stilton cheese by keeping the cut surface moistened with an occasional glass of port wine. The doctor can tell something of their ravages on the human frame; whilst everybody who has seen stale bread, damply-kept clothes, old boots, etc., covered with a bluish-green film has recognised the "mould" at work. The more careful botanist is aware that every species of flowering plant is attacked by one or other of these vegetable parasites. Their name is legion, and their distribution universal!

We propose calling attention to a few of these ubiquitous pests which habitually infest some of our most useful plants. They exceed in number of species our flowering-plants, and they have such a Proteus-like mode of changing their external shapes and habits of life that even botanists have been led astray, and have described them under different generic as well as specific names. Not unfrequently they pass their vegetative stage on one plant, and their reproductive stage on another. They are, in this respect, similar to such parasites as the Tapeworms, which require two different kinds of animals to shelter them whilst they pass through their several gradations of growth. Indeed, the changes which many of the lower animals and plants pass through before they reach maturity is one of the most interesting branches of philosophical natural history. For generations we have been acquainted only with the well-marked stages or conditions of life through which butterflies or beetles pass. That has long been a stock subject for wonder. But, suppose the caterpillar never reached any other condition, but died after laying eggs in the caterpillar state; and that these eggs became, not caterpillars, but chrysalids, which in that state also laid eggs and then died; and further, that the eggs of the chrysalids became the gorgeous butterflies—would not this requirement of three individual lives to complete one circle of existence seem more wonderful still? But that is exactly the mode of development of many of our jelly-fishes, and it is particularly so of most of the minute vegetable parasites which we know by the popular names of "moulds" and "mildews."

Many of these objects are wonderfully beautiful when viewed under the microscope, especially those to be found on the stems and leaves of buttercups, nettles, speedwells, goat thistles, etc. They are of a bright red colour, and look like little vases with fringed mouths. They go by the names of "cluster-cups," and we have many hundreds of species, one or more parasitic on every species of wild plant. A good deal has yet to be discovered and written about the relation of these "cluster-cups" to other vegetable parasites, and especially as to the reasons why they often affect one order of plants rather than another. They must have been created *after* the plants on which they are found, for they could not exist in their present state otherwise. The Berberry bush has frequently the undersides of the leaves covered with a peculiar kind of "cluster-cup," and old Norfolk farmers stuck to it for years that berberry bushes caused mildew in wheat. This was in the days when botanists believed in *specific* creation, and consequently they laughed at any supposed connection, not merely with the berberry bush, but even with its parasitical "cluster-cup" and the wheat mildew. But times have changed. Few botanists of any standing now hold the doctrine of the unchangeableness of species, and the scientific liberty of conscience thus gained has enabled them to account for a good many phenomena that were before unaccountable, and to be less dogmatic as to what is and what is not. Certainly no two vegetable parasites seem more unlike each other than the berberry cluster-cup and the wheat mildew. But science has recently proved that the observations of the Norfolk farmers were right, and the conclusions of the botanists wrong. Professor de Bary, one of the most eminent authorities on these matters, has sown the spores of the berberry cluster-cup, and reared a crop of microscopic fungi, whose spores, when sown under proper conditions, become wheat mildew! So much for the "biffins"!

All true vegetable parasites thrive best where nitrogen is present, and as it is always more abundant in the cells of *growing* plants than at any other time, they are usually found attacking young plants. We believe that *over*-manuring has done a great deal to nourish these pests, owing to the excess of nitrogen which is then likely to be present. The under surfaces of most leaves are crowded with stomata or breathing mouths, by which the atmospheric air obtains admission to the interior of the leaf, and any carbonic acid it may contain decomposed, the carbon absorbed, and the oxygen returned to the atmosphere. Small though these breathing mouths are, the *spores* are smaller still, and as they are nearly always present in the atmosphere, they pass into the interior of the leaf, and there germinate. First they throw out long, white threads, which ramify amid the interstices of the cells, tapping the latter on their way for support. Presently the parasite comes to the outside, either by breaking through the skin or stem, or otherwise, in order it may develop its spore-cases in such a way that the spore-dust can be shed into the atmosphere. It is an advantage to the parasite that one stage may thus shed spores which, when they germinate, shall develop the next condition in the growth, and then a third, and so on. It is a kind of "division of labour." The "rust" in wheat, which we may see covering the outside of the culms when young, near where the leaves strike off, is a case in point. This generally appears in May. Examine the same plant a month or two later on, and there will be seen small brown pustules scattered among the rust. The third stage is reached just before the time when the corn should ripen, and then we have a change to numberless black spots, about the size of a pin's head, and this is the full-blown mildew. Of course, all these live by absorbing that sap which ought to have gone in developing the grain; and as they largely intercept it in its rise, we need not say the ears of wheat come off "second best"!

"Bunted" wheat is due to another kind of vegetable parasite, or microscopic fungus, which penetrates to the very grain itself, puffing it out so as to deceive the uneducated farmer into believing his crop looks extra promising; and then, when ripened, bursting the as yet unbroken skin, and showering forth an enormous mass of stinking spores of a greasy character, so that they are sure to stick where they alight. Hence the necessity for washing seed-corn in some strong alkali before planting, as the greasy spores are then certainly washed off. There are reasons to believe that "bunt" first begins with the seed, grows with the growth of the plant, and reaches its maturity when the plant should also do so. "Smut" is yet another vegetable parasite which agriculturists have to do battle with, and its ravages are effected slily and specially. It does not put in its appearance until the wheat is in bloom, and then attacks the pistil, covering it with black spores, living on its delicate vitality, preventing its being fertilised by pollen, and, in short, utterly precluding the possibility of any grain being produced under such circumstances.

"Ergot" is a vegetable parasite, recently described in all its stages in the *Journal of the Royal Agricultural Society* by William Carruthers, F.R.S., of the British Museum, one of the best botanists of the day. It usually attacks grasses, and causes cows feeding on such herbs to slip their calves. It is especially fond of rye, and the fearful diseases it causes in countries where rye-bread is largely eaten, when it has attacked the crops, are among the most hideous of human afflictions. The limbs literally rot, the flesh sloughs off them—these are but part of its hellish operations! Damp marshes and undrained lands are the most liable to nourish the "ergot," whose spores winter in the ground till spring comes and the tender young grass appears. There are many reasons to believe that the "Cattle Disease" of 1865 was largely due to the enormous abundance of vegetable parasites, and their effects on the cattle eating food affected by them. Many farmers will remember how frequently during the summer of that year they could not walk through the grass without the boots and trousers being dusted with hosts of red spores.

One of the difficulties in tracking these insidious and invisible enemies from one outpost to another has hitherto been in finding where they *wintered.* If they are purely parasitic, it was thought they must winter in some plant, but which? All are dead then. Carruthers has shown that the "ergot" winters in the earth, or, rather, a special spore-case does so. Thence they emerge next spring. And very recently Mr. Worthington Smith—another of our best fungologists—has written a long elaborate paper on the "Resting-spores of the Potato Disease," in which he shows that this parasite also winters in the ground, in one form, by means of a special apparatus. Or the latter fungus may be *nursed* by other plants of the same order, such as the woody nightshade of our hedgerows, or the tomato, which is also a species of potato. At any rate this, the newest discovery in connection with the life-history of these pests, is important; for all will admit that a thorough knowledge of the disease is half the cure. All honour to such men, who, without fee or reward, devote their leisure time to researches which demand an amount of patience certainly "rarely seen in men, and never in women"!

Next to the mildew, rust, bunt, and smut, the potato disease fungus (*Peronospora infestans*) is certainly the most important. It attacks one of the main sources of food supply, and that, too, in poor men's grounds as well as rich. Many an honest workman, who has toiled in his "bit o' garden" after tea, until the shades of evening gathered thick around him, has found, before the end of July, that he has only been supplying food for the potato disease! He gets up some morning, after a night's rain, and behold the green tops, which have been daily watched, are drooping their heads and looking sickly! It is no use fretting—the "disease" has got hold of them. We advise him at once to take a scythe and mow down the stems as close to the ground as he can, for the disease generally begins with the leaves, makes its way down the stem, and then to the tubers or potatoes. If he take this advice, he may perhaps dig up his potatoes untouched; they may not be ripe enough, but let him make what he can of them. A little gain is better than all loss.

The potato-disease fungus is of very rapid growth. Under the microscope it can be seen ramifying in and out of the leaf-cells, and then hanging out of each of the breathing holes underneath a branch of whitish, beaded-shaped twigs. Each of these bead-like objects is full of spore-dust, and the slightest touch detaches it. It grows so rapidly that if one potato plant be affected, the disease will soon be communicated to an entire field. As the plants are generally set so thickly that their leaves come into contact, especially if it be wet weather and there is a wind blowing, it follows that the mycelial threads or "spawn" of the fungus can roam over the entire area of plants in an inconceivably short space of time. Should the disease be allowed full play, it will at last reach the tubers or potatoes, and speedily convert them into soft masses of putrid rottenness. The ground then becomes thoroughly saturated with fungus spores, and there is little wonder the disease should thus be perpetuated.

Two or three things are worth noting in connection with the arrest of this terrible pest. First, it is found that in Cheshire and Devonshire, where the soils are quite red with oxide of iron (iron rust) derived from the decomposition of the New Red Sandstone Rocks beneath, there is nothing like the amount of potato disease there is in richer and equally light but blacker soils elsewhere. The idea has been suggested, with a good show of probability, that the arrest of the disease is due to the presence of iron in the soils where the potatoes grow. The experiment of proving this is an easy one, and we have advised that in Suffolk a top-dressing of the Red Crag, or ochreous sands overlying that geological formation, should be tried. It can do no harm—it may do a great deal of good. Still, we cannot but think that it would be wise to strengthen the strained vitality of the potato plant by crossing varieties from potatoes raised from seed. No other plant has been so much propagated by shoots as the potato, and so far we have forced nature to an extraordinary degree. The potato plant is provided with the ordinary means of propagation by flowers and seed, and we cannot but think that the strongest plants, and those most liable to resist the attacks of the vegetable parasite, would be the varieties from a crossing between seed and shoot. It is almost certain that such a return to normal conditions would tend to restore the vitiated energies of potato plants.

Again, the potato disease rarely makes its appearance before July, and it has been suggested by Professor Dyer that if we were to cultivate *earlier* kinds of potatoes we might evade the disease. There is a good deal to be said in favour of this notion, and for a time we might ward off the danger. At the same time the potato disease would in probably a short period of time come up with its victim, and also produce *earlier* varieties. Mr. Smith has shown that he found potato disease a year or two ago as early as the beginning of June. We feel convinced that the best and most certain means of resisting the attacks of the potato fungus would be to raise a new variety of stronger and healthier plants by crossing. The weakest must go to the wall—it is one of nature's wise though implacable laws; and weakly plants not only get attacked first, but nurse the disease through enabling it to grow by what it feeds upon.

Time and space forbid us to do more than mention that "Pea-blight," "Bean-blight," "Rose-blight," etc., are also due to the attacks of vegetable parasites. Hardly an organism on the face of the earth is free from them, and the wonder is that they continue through countless ages to resist them. The prickly thistle can no more resist them than the succulent potato—they attack the palm-tree as well as the rose-bush. Man is in the position of umpire—he can throw the weight of his influence and interference into the scale, and thus protect those more highly organised plants that are useful or necessary to him in many ways, best by understanding the nature of the enemies to which they are subjected.

CHAPTER XXIII.

THE TIME OF CATKINS.

GENERAL science has been pouring new facts into the treasury of human knowledge, but none have been so fascinating as those relating to flowers. It is not a difficult matter to say what intelligent people will think about Darwinism and Evolution a hundred years hence. The publication of the *Origin of Species* twenty-one years ago gave a new impetus to natural science. It is no longer, as Dr. Johnson contemptuously declared it, "a study fit only for children." A new philosophy has been built up out of its recent discoveries, a philosophy which touches our most cherished beliefs and conclusions at almost every point.

Hitherto the opponents of the new philosophy have been contented with ridiculing it, and have been unable to see that the reason why the advocates of the latter have not replied is that they are too much in earnest in pursuing the temptingly new lines of investigation open to them. There is too great a tendency to forcibly stereotype all fresh facts into the old or the new moulds of theory. What have genuine students to do with these? What we want is the "Truth, the whole truth, and nothing but the truth," whatever it may be! Sincere investigation, and a loving reverence for the work we are engaged in, must inevitably bring us nearer to the "Father of lights!"

Let us remember that, as Lord Bacon so long ago remarked, the conclusions of true science are but "the Word of God revealed in nature." Every organic object has assumed its shape, has vegetated and enjoyed individual existence, and has accumulated force enough in the meantime to reproduce its own kind, and thus perpetuate the heavenly beauty which hangs like a halo over every thing that hath in it the breath of life! With that instinctive feeling of the presence of a truth not yet revealed, some of our most eminent modern poets have given expression to ideas which rigid science has since declared to be true. The Word is nigh us, if men would only believe. Goethe was the first to point out the unity of structure which is at the base of all flowers, and even the still greater simplicity which underlies the composition of plant, and shrub, and tree. Cowper spoke of the "freckles, streaks, and stains" which in most flowers "show signs of His unrivalled pencil;" and the discoveries of Sprengel, Müller, and Lubbock have now placed the world in possession of the vital reasons which belong to both colour and form in flowers. Wordsworth, with his almost pantheistic reverence for nature, declared that, to him,—

> "The meanest flower that blows can give,
> Thoughts that do often lie too deep for tears,"

No one can understand the fulness of this sentence who has not learned to see in some of our commonest flowers evidences of structural adaptation and ancestral modification which go backward into the geological ages. The mode in which plants have been scattered in great colonies, with genera grouped together and sharing in each other's migrations as if they had been Highland clans, over all parts of the world, can only be understood in the light of the geological changes which have forced such emigration.

Again, just as no man liveth to himself alone, so no flower exists by any aristocracy of birthright. We have plants that associate together, in some kind of not yet understood commensality, such as our buttercups and daisies, nettles and docks, dandelions, and hawkweeds. More striking still is the contrast between plants bearing brightly and even gorgeously coloured flowers, with corollas of graceful shapes, and others in which there is a general absence both of form and colour to delight the eye. What is the meaning of such a contrast? Does nature acknowledge *caste*, or have we here only an analogy to that strange modification which elsewhere adapts one mammal to a fish-like form in the whale, and another to a bird-like shape in the bat?

For generations we have regarded the "pole of the earth as passing through the perpendicular" of each one of us. The whole organic world has in our thought been made to revolve around the last created form, just as the solar system continually whirls around the sun. With an impertinence so great that it partook of sublimity, we have rudely challenged the right of any animal or plant to existence, except in so far as it was useful to ourselves.

Science, with its Ithuriel spear, has touched to the quick many of our selfishly-cherished notions; but none more than those we have entertained about flowers. In their place, however, she has given us others of loftier enjoyment, suggesting a more reverential faith in the eternal wisdom of Him who "clothes the lilies of the field," and knits the whole organic universe of animals and plants, past, present, and to come, into one scheme of ineffable beauty.

Let us take certain objects early to be seen along our country hedgerows and by the margins of our streams, as types of one of the two great divisions of flowering plants which modern botanists have recently made. Our hazel and willow catkins are familiar objects to all people,—country folk and town-dwellers, old and young. The former are the first promise of the coming summer, and a cheering token that the sternest attacks of winter have passed over for another twelve months. The latter will make their appearance later on, and will light up the olive-green osier banks with their cheerful yellow and silver colours. Nothing could be more strongly contrasted than the catkins of the hazel and willow: the former so unpretentious, and the latter so gaudy and showy. A month or two will pass away and then we shall see similar pendent catkins of the poplar, and the rounder cone-like flowering parts of the alder. The naked twigs are tinged with a warm red, that tells us plainly of the quiet work the rising sap is effecting. The silver birch will also assume its wedding garment of catkins, so like those of the hazel that without the trees a tyro would have some difficulty in making out a difference.

The two types of flowering plants are those named *anemophilous* and *entomophilous*. It is one of the besetting difficulties of science that she is constantly forced to coin new words wherewith to express new facts. Science would be nothing if it were not strictly accurate in its method of formulating all its additional discoveries. A word must mean so much, and nothing more nor less,—therein differing from ordinary parlance, which is rarely characterised by this peculiarity. The two words just mentioned are newly coined: fresh from the scientific mint. Let not the reader dread them,—they have a meaning, and will serve as the centre around which a good deal of excellent botanical and other natural history knowledge will group by the law of association of ideas. *Anemophilous* is the name given to all that class of plants which, like the catkins of the hazel or birch, have the pollen conveyed from them to the pistils by the agency of the wind. *Entomophilous* is the term applied to that larger and more typical group of flowers which are fertilised by means of the vast army of summer insects, flies, bees, butterflies, and moths, whose lives seem to be passed in the elysium of flower-land. It is to tempt them to this floral visitation that all the fascinations of flowers are spread forth—colour, perfume, and honeyed nectaries. Those sweet and delicate odours which we have assumed could not have been created for other than human nostrils, were evolved by this set of plants in order to promote insect fertilisation by offering insects an inducement to visit the flowers. The bright colours are equally effective means of arresting the vagaries of the winged tribes of the air. Hence we see that butterflies are not the sybarites we have often deemed them, but, in conjunction with less attractive insects, are engaged in that work of floral crossing which ensures the healthiest condition to plants. Without them we should not have the feast of perfume and colour with which our summer woods and meadows are spread. Without insects it would be in vain for such a feast to be laid out; for, even though man could enjoy it, he could not make that necessary equivalent to the givers of the feast which is necessary to their existence!

The plebeian floral organs of the hazel are endowed with none of the patrician ornamentations we have been discussing. Nothing could exceed the humble attire of this plant. Few, except botanists, are acquainted with its wedding garments. You take one of the pendent catkins and examine it more at leisure; observe how it is a string of stamens, like those you may see clustering so thickly in the interior of the common buttercup, only not so gaudily coloured. Two of the stamens go together: their heads hang downward, and above them is a sort of sloping pent-house, formed by an aborted leaf called a *bract*. This causes the rain to fall off without injuring the stamens,—in fact, it serves as a kind of miniature floral umbrella. The light-coloured stamens are literally *pollen*-bags, borne on short stalks. If they are thoroughly ripened you can readily open the bags with the tip of a penknife, by simply rupturing the skin. The pollen grains then come forth in swarms. Take some of them home, and examine them with a good microscope. You notice how *thin* they are, as if for the purpose of exposing the largest possible amount of surface. Compare them, in this respect, with the pollen grains you may similarly obtain from an insect-fertilised plant, such as the buttercup or primrose. The latter are roundish, and generally covered with what appear to be prickles, or roughened points of some kind or another. So well marked is the division between insect-fertilised and wind-fertilised flowers, apart from their contrasted colours, that it extends even to the microscopical grains of pollen ; and a competent botanist can tell from the latter alone whether it is derived from one or the other of the two groups.

It requires little perceptive power to see the reason for this difference in the shapes of the pollen-grains. The thin, smooth, or angular grains of the hazel are just the sort to be best carried by the wind, for they present the greatest amount of surface to it. They are lighter than the others, so as to be more readily blown about. On the contrary, we see how the round pollen-grains of the buttercup, with their roughened or prickly surfaces, are admirably adapted for sticking to the hairy bodies of insects, so as to be carried about from one flower to another, and thus bring about cross-fertilisation.

Even the mode in which the *anthers* or pollen bags of flowers open, to discharge the pollen grains, is various. Sometimes the bag splits in two, a very common plan ; occasionally it ruptures at the top, or allows the pollen to explode through trap-door-like holes. The number of pollen-grains yielded in the total crop of this little hazel catkin would be incalculable. And yet each is fashioned on the same plan. The catkin itself is delicately pendent, so that it may sway to and fro in the wind, and the pollen in this manner be as largely diffused through the atmosphere as possible. Those of the birch and poplar are similarly pensile, the latter generally at great heights in order that the largest mechanical effect may be given.

With the exception of the grasses, all of which are wind-fertilised, *anemophilous* flowers generally come forth early in the year, before or about the time when the daffodils are decking the woods of March with beauty. The wind then blows its keenest, uninterrupted by the dense foliage which will gather in massiveness as the summer months come on. The absence of leaves, therefore, must be exceedingly favourable to the dispersion of pollen-grains by the wind, and as the trees and shrubs we have mentioned are usually clad in a garment of thick leaves, we can see how advantageous it must be for them to flower before the leaves bud to interfere with the wind carrying their pollen. Many of the wind-fertilised plants are *perennials*, so that their first store of energy is expended in developing excessive pollen. On the other hand, a great number of our most showy flowers are annuals, whose first act of growth is purely vegetative, developing leaves which will store up the energy for the ultimate formation of flower and seed.

In them reproduction is the last act of life; in the poplar, hazel, birch, and alder, it is the first.

One can now understand why the wind-fertilised flowers should be obscurely coloured, or not at all. The wind needs no bidding for its capricious visitations; colour, and perfume, and honeyed nectary do not prevent it blowing where it listeth. Beauty cannot delay it in its circuits, nor can appeals to the senses of smell and taste cause it to halt: the latter must be laid out for conscious, not unconscious objects. There must be present an eye to see, a nostril to smell, and a palate to taste, such as most of our winged insects possess. The elm, hazel, birch, alder, poplar, pine, fir, oak, the ash, partly the hop, nettle, and grasses of all kinds, including the cereals, are married by the fickle wind: all of them have light pollen grains which we have seen are so admirably adapted to be blown about. Many of them have the sexes on different trees, so that a wind-marriage is absolutely necessary for the perpetuation of the species. In the hazel both sexes are on the same individual shrub, but never together. Look at any hazel bush early in the year, and let your eyes travel along the naked twigs from the pendent catkins towards the tips of the branches. Here and there you will see small, round, leaf-like buds, terminating in half-a-dozen feathery, bright scarlet threads. These are the *pistils*, —the representatives of the gentler sex,—awaiting the arrival of some minute pollen grain; just as the princess in some Oriental story patiently waits for the appearance of the invisible prince who is to marry her. Like an unseen good fairy, the wind brings the two together; and the result is the clusters of ripe, brown nuts, which make a hazel copse so tempting in the early autumn time. As soon as the pollen grain has touched the red threads, it begins to shoot forth a tube which penetrates to the base of the pistil, and fertilises the ovary. All pollen grains, whether carried by wind or insect, act in the same manner.

The wind-fertilised plants are some of them occasionally visited by insects, for the sake of their pollen. Some insects actually feed on it, or rather resort to it for an occasional meal. But though they may thus carry away odd grains of pollen, they never fertilise the separated pistil with it, for the simple reason that she has nothing to offer as an inducement for them to visit her. Unlike the bright yellow male catkins put forth by the various species of willow, —the "palms" of the children in the northern and midland counties,—the dangling wedding garments of the hazel are obscure, and are only noticeable on account of their early appearance and their mute prophecy that the roughest storms of blustering winter may be regarded as over.

Although the catkins of the willow have no petals, and but a faintly sweet perfume, the gorgeous yellow is unusually attractive to early insects, especially in the general absence of floral competition. The yellow catkins are the male plants ; the colonies where the stamens are collected together, always on a different shrub from the females, or pistils. You may see such willow bushes a mass of glorious yellow, delighting the eye with the near approach of spring. Each catkin is upright, not pendent, like those of the hazel, poplar, and birch. The wind undoubtedly often acts as the occasional registrar of willow-marriages, but the bees are the old-fashioned, orthodox marriage-priests. Spring is the time of year when these proverbially industrious insects are on the wing, and the abundant pollen of the willow comes in usefully to furnish "bee-bread," and for other purposes. The silvery catkins of the willow we are sure to find not far off the yellow catkins, are colonies of females or pistils. Notice the graceful shape of each, how flask-like it seems, except that the summit is forked. That summit is just appreciably sticky, so that any pollen-grain brought to it would be certainly fixed, whether brought by wind or bee. Not unfrequently, in some osier carr, we may see male and female willow shrubs growing thickly together, so that the wind rustles the branches against each other, and marries them against their will.

CHAPTER XXIV.

THE FLOWERS OF THE PRIME.

HOW many of the excellent things which the earlier poets said of the early part of May seem strange to those who forget that with the introduction of the "new style" into our calendar a century ago, we skipped over eleven days. Consequently, the old "May day" about which we read so much does not really come until our 12th of that month. By then the "May" (dearest of English plant-names) is out. Every country roadside is a perfect garden of delight. The hawthorn bushes are covered with floral masses of snowy whiteness, whose faint odours are just tinged with that perfume of almonds which tells us that prussic acid is present. The hedge-banks are begemmed with clusters of sky-blue veronicas, the "birds' eyes" of rustic infant botanists, among which we have bunches of white stitch-worts, the "milk-cans" of the same nomenclature. Here and there, perhaps, solitarily rises a red campion, a flower whose blood-red colour earned for it its ancient Danish military name. Not far from "the huts where poor men lie," and on the moist, shady sides of the country lanes, the Primroses gather thickly, their characteristic colour standing out in bright relief from amid the dense leaves which serve as a background. Some of its early pioneers came in with the catkins, and kept floral company with them. On southern banks the primrose has been brightening the otherwise dull, wintry waste with its pale stars, and has been prophesying in its mutely eloquent fashion of the summer that would come again! Burns aptly calls this gentle flower—one of the many favourites of British poets,—"the firstling of the year." And so it is, the darling and the pet of the early spring months, over whom the rude blasts blow in vain, and the keen frosts fail to nip its delicate flowers. Its common name of "primrose" is nearly as Latinised as its technical botanical one of *Primula vulgaris*. In old books we find it spelt as *Prym rolles*, and it was termed "the first floure in Pryme tyme." Chaucer calls it *Primerole;* whence we have Primrose. The rightful claimant of "Primrose," or "rose of spring" is the Daisy. The ancient

Romans, and perhaps the Greeks, were cheered by the early advent of our modern Primrose. It has long been regarded as the emblem of *youth*, so delicate and tender is the impression one gets of its flowers. Burns had followed Carew in calling the Primrose as above :—

> "Ask me why I send you here
> *This firstling of the infant year;*
> Ask me why I send to you
> This primrose all bepearled with dew.
>
> * * * *
>
> Ask me why this flower doth show
> So yellow, green, and sickly too;
> Ask me why the stalk is weak
> And bending, yet it doth not break."

Shakespeare speaks of it in "Cymbeline" as emblematic of the youthful dead :—

> "With fairest flowers,
> Whilst summer lasts and I live here, Fidele,
> I'll sweeten thy sad grave : thou shalt not lack
> The flower that's like thy face, pale primrose."

There is something about the look of this humble flower that impresses one with the idea of sadness. The eye of the flower looks up at us with such a mute appeal for sympathy, as if with us it felt the burden of this strange mystery of creation.

In the strength of the delicate stalk which poises each flower, in the semi-droop of the flowers themselves, we have an adjustment to the specific gravity of our planet as a whole, and perchance a relationship manifested with the entire solar system. Although this adornment of organic forms in all the glory of perfume and shape and colour is mainly for the purpose of propagating flowers, yet the necessity for their being propagated at all may in its turn be to administer to higher things. If winds and insects unconsciously act as the marriage-priests for all kinds of flowers, who shall say that flowers also do not exist to unconsciously fulfil an important mission to other forms of life? Many of the world's best and most spiritual thoughts have been suggested by these pale-eyed messengers of God! Mungo Park only put forth in a matter-of-fact manner the influence which the little moss had on him when far away in Africa, the same kind of feeling which all of us who love nature have felt when we have held communion with the flowers. These flowers, many of them, even suggest moral qualities or mental conditions. What can be more strikingly contrasted than the sweet, sad look of the pale primrose with the joyous appearance of the wild dog-rose? What human characters differ more than the unpretending modest daisy and the gaudy, noisy-looking tulip?

Why the idea of *youth* should be associated with the primrose it is difficult to tell, unless from some such unknown suggestion as those just referred to. Shakespeare again alludes to this notion in his "Winter's Tale:"

"Pale primroses,
That die *unmarried* ere they can behold
Bright Phœbus in his strength."

Something of the feeling which poor Clare has so simply described comes over us at the sight of the first primrose: it carries us back to the distant and never-to-return days of innocent childhood, when each of us, like the poet,

"Robbed every primrose root we met,
And ofttimes got the root to set;
And joyful home each nosegay bore,
And felt—as we shall feel no more!"

It is not difficult to understand the strange sensation which came over the rude Australian diggers when there accidentally shot up in their neighbourhood an English primrose, whose seeds by some means had been brought over in the various "packing material" from the old home.

The sight of a densely-thronged primrose-clad bank, in April or early May, will affect all but the most callous. Wordsworth very properly places the men to whom these flowers come with no hidden meaning or suggestion, in the same group as poor, half-crazy "Peter Bell," to whom

"A primrose by a river's brim
A yellow primrose was to him,
And it was nothing more."

Before Wordsworth's time, a now-forgotten poet, Browne, had associated the idea of thoughtlessness with neglect of this same flower :—

"As some wayfaring man passing a wood
Goes jogging on, and in his mind nought hath
But how the primrose finely strews the path."

When the green meadows are clad in floral robes of primroses, cowslips, daisies, buttercups, and cuckoo flowers, we are forced to say, with quaint, nature-loving Isaak Walton, "When I last sat on this primrose bank and looked down these meadows, I thought of them as Charles the Emperor did of Florence,—that they were too pleasant to be looked on but only on holidays."

Professor Wilson ("Christopher North") refers to the sad looks which primroses wear, and speaks of them as

"Primroses, which droop about
Some self-consuming care,
So sad, so spiritual, so pale;
Born all too near the snow,
They pine for that sweet southern gale
Which they will never know."

Herrick seems to have been struck with something like the same idea as he strolled through the dewy, primrose-clad hedgebanks of the Devonshire lanes. He addresses them thus :—

"Why do ye weep, sweet babes? Can tears
Speak grief in you,
Who were but born

Just as the modest morn
Teemed her refreshing dew?
Alas: you have not known that shower
That mars a flower,
Nor felt the unkind
Breath of a blasting wind;
Nor are ye worn with years,
Or warped, as we
Who think it strange to see
Such pretty flowers, like to orphans young,
Speaking by tears before ye have a tongue!"

Perhaps, in all the rich treasure-house of British poetry, the primrose nowhere has suggested such lofty thoughts, showing the cosmical relations of this plant, as in Wordsworth's exquisite poem of "The Primrose of the Rock." He there speaks of it as

"A lasting link in nature's chain
From highest heaven let down.

"The flowers, still faithful to the stems,
Their fellowship renew;
The stems are faithful to the root
That worketh out of view:
And to the rock the root adheres,
In every fibre true.

"Close clings to earth the living rock,
Though threatening still to fall;
The earth is constant to her sphere,
And God upholds them all:
So blooms this lonely plant, nor dreads
Its annual funeral."

The "pale primrose" might have been the flower similarly referred to by Edwin Waugh, the well-known Lancashire poet, in one of his most touching poems, the "Moorland Flower:"—

"Beneath a crag, whose forehead rude
O'er-frowns the mountain side,
Stern monarch of the solitude,
Dark-heaving, wild, and wide,
A floweret of the moorland hill
Peeped out unto the sky
In a mossy nook, where a limpid rill
Came tinkling blithely by.

* * * * *

"The green fern wove a screening grove
From noontide's fervid ray,—
The pearly mist of the brooklet kissed
Its leaves with cooling spray;
And when dark tempests swept the waste,
And north winds whirled wild,
The brave old rock kept off the shock,
As a mother shields her child.

"And when it died the south wind sighed,
The drooping fern looked dim,
The old crag moaned, the lone ash groaned,
The wild heath sang a hymn,
The leaves crept near, though fallen and sere,
Like old friends mustering round;
And a dewdrop fell from the heather bell
Upon its burial ground:—

"For it had bloomed, content to bless,
Each thing that round it grew,
And on its native wilderness
Its store of sweetness strew.

Fair link in nature's chain of love
  To noisy fame unknown,
There is a register above
  E'en when a flower is gone!"

Goldsmith makes this flower point one of his homely morals:—

"Her modest looks the cottage might adorn,
  Sweet as the primrose peeps beneath the thorn."

Beaumont and Fletcher, in the "Two Noble Kinsmen," refer to it as the

"Primrose, firstborn child of Ver,
  Merry spring time's harbinger."

But enough has been said to prove that this pretty flower subserves a higher end than that of merely bringing about insect agency to assist in cross-fertilising it. There are more things in heaven and earth than are as yet dreamt of in our philosophy, keen-searching and exhaustive though it be! Bunyan, in his *Holy War*, tells us that "Emanuel entered in at Ear-gate," and, similarly, one of the paths to heaven may be that strewn with the flowers.

Turn we now to the delicate floral machinery by which so much beautiful thought has been suggested. Tennyson tells us that the

"World's bread hangeth on the shedding of a seed,"

and it is very certain that the floral robes which annually clothe the rich surface of our planet depend upon the various agencies which carry almost microscopical grains of pollen from one plant to another. The contrasted nature of these agencies, one inanimate, the other animate, we have already explained in a former chapter; and the reader will be prepared to expect that insects are the chief, if not the only, marriage-priests which unite primroses.

You cannot gather a bunch of primroses, and examine the throats ever so slightly, without perceiving that nearly the same kind of corolla in reality encloses two different types of floral structure. In one, the pistil comes up level and flush with the throat of the flower, terminating in a pin's-head-like summit; in the other it is half-way down. Similarly with the five stamens: in the former they are half-way down the throat; in the latter they occupy the surface, or surrounding entrance to the throat, the place where the pistil-head stands in the first-mentioned kind. Stamens and pistils, in fact, change places. In a handful of primroses you will find these two kinds about equal in number. This peculiarity has long been known, and the popular names of "pin-eyed" and "thrum-eyed" have been and are given to them respectively. What does it mean? The reverent student is prepared to expect that it fulfils some important function in the economy of the species, and modern botanical science assists him to an explanation. If he examine the *pollen* from the stamens occupying these two positions under the microscope, he will find they differ in size and shape. The pollen-grains from the primroses possessing long pistils are only about two thirds the size of the other. Our garden polyanthuses and auriculas, which are nearly allied to the primroses, often display the same double type of floral organs. The cowslips and oxlips also have it in as high a degree as the primrose itself.

The discovery of this double set of stamens and pistils, the former differently placed, and the latter of different lengths, has brought to light a large number of instances of other flowers in which a similar and even extreme differentiation occurs. Perhaps it is nowhere so well marked as in the purple loosestrifes, (*Lythrum salicaria*), which in June will be seen fringing the margins of our weed-grown ponds and tarns with the rich light purple of their loose and showy blossoms. The purple loosestrife has three sets of pistils—long, middle-sized, and short—as well as three sets of stamens—long, middle-sized, and short. No one would think of it who did not carefully examine the interior of one of these beautiful flowers, for all are alike enclosed with the same kind of corolla. The name given by botanists to this remarkable differentiation in the case of the primroses and cowslips, where it is double, is termed *dimorphism;* in that of the purple loosestrife, where it is a threefold character, it is called *trimorphism.* The law extends to a great many flowering plants, but we have thought proper only to name the above as types.

Now, a truly reverent and philosophical naturalist will not be content with regarding this law of *dimorphism* and *trimorphism* as simply curious. Whatever Darwinism has done, it has at all events given the death-blow to that spurious theology-in-science which deemed it possible for the Creator to indulge in capricious zoological and botanical freaks! Those who believe in the meaning, either in present activity or representing a former active condition, of every organ or character, are much more likely to be nearer the truth, than those who ascribe all they cannot understand to a mystic caprice more difficult to understand still.

Every botanist now knows the great importance of *crossing*. Remembering this, and knowing what we now do of the use to which these double- and treble-shaped floral organs are put, we can understand their direct use. It was shown by Darwin, in a paper read before the Linnæan Society when this problem was first explained, how a *dimorphic* set of flowers could be useful to one another. We can see that an insect thrusting down its proboscis into the throat of a primrose or a cowslip in which the pistil was a long one, so that the head came level with the throat, would dust it with the liberated pollen at a part which, when the insect visited a short-pistilled flower, would just touch the pistil of the latter, and so both cross and fertilise it. Similarly, when it visited the latter flower, in which the stamens occupy the entrance to the throat, it would likewise be covered by their pollen at a part which would be the first to come into contact with the first-mentioned primrose (the long-pistilled form), and so would also cross-fertilise it. One insect would thus cross two different sets of flowers in such a way that, owing to this *dimorphism*, both would be absolute gainers.

In the case of the purple loosestrifes, the changes rung by the threefold lengths of the pistils and stamens are more remarkable still. It has been found that perfect fertility of seed can only be produced when the pistils of one of these three lengths are fertilised by the pollen brought from some other flower where the stamens are of the same length. In these strange modifications of the purple loosestrife, both seeds and pollen-grains of the three varieties differ in size. Even the colour varies in the pollen produced by these sets of stamens, being green in the long and yellow in the shorter forms. A sort of multiple proportion agency sets in when we get to these *trimorphic* types of flowers. The number of crossings which can be rung is much greater than in the double-organed flowers, such as the primrose and cowslip. Thus Darwin concludes that *eighteen* modes of crossing are possible in the flowers of the purple loosestrife. Little do the insects which frequent these plants, attracted by the gaudy colours of the loosestrife, or the conspicuous flowers of the primrose—conspicuous partly from the absence of floral competitors—know that they are unconscious agents in carrying out the first organic commandment! We have deemed their tribe as among the sybarites of the animal world; and, lo, we suddenly awake to the fact that, without their assistance the world would never have had its floral robes! How many more fallings away of the scales from our eyes will take place under the keen scrutiny of modern science, we cannot say; but certain it is that any theory which opens them so as to take in a wider and better perspective view of the universe, brings us nearer to its Creator!

The nodding, umbel-like flowers of the cowslip, with their deeper-yellow, mottled colour and fragrant perfume, are near relations of the more modest primrose: our "meads in May" are crowded with them in many districts. Here and there, scantily distributed among the cowslips, we find the oxlip,—a distinct species, with larger, primrose-like, paler flowers: whose name of "ox"-lip seems to have been given to it on account of its flowers being larger than those of the "cows"-lip. The latter flowers are nearly as great favourites with us as the primroses, and perhaps would be so altogether if they were as abundant. James Montgomery, like a true poet, reflects the thought of all lovers of flowers:—

> "Now in my walk, with sweet surprise
> I see the first spring cowslip rise:
> The plant whose pensile flowers
> Bend to the earth their beauteous eyes
> In sunshine as in showers."

The primrose family affords the philosophical botanist a good illustration of the strong lines which mark off species from one another, by a simple arrest or development of parts they all possess in common. For instance, in the common primrose we find that the peduncle, or stalk, is arrested in its development: in fact, it never shows itself at all; and so the primroses spring singly, but in clusters, on their short, slim pedicels. In the cowslips and oxlips, however, the peduncle is developed; and so in them we have the separate flowers springing, as if forming an umbel. In the now well-known Chinese primrose (*Primula sinensis*), which beautiful plants are to be found in every collection, the peduncle attains even a more prolific development. Not content with simply shooting up from the stock so as to bear an umbel of flowers like the cowslip, it rises so as to bear one such umbel, and then springs upward to a distance and bears another; afterwards shooting higher still, perhaps to be crowned with a third set of flowers. All this variety is produced by the simple shortening or elongation of the pedicel, or flower-bearer. It is difficult to impress on the minds of people unacquainted with structural botany the marvellous variations which can thus be wrought. But as all sounds are produced from low or rapid vibrations of the air, all colours from the fast or faster undulations of the light-ray; similarly with these living parts of plants, all the wonderful modifications which fill the world with floral beauty are the consequence of the simplest alterations ; which, like the turn of the kaleidoscope, with the same materials produce such a vastly different effect as to lead those who are unconscious of it to believe in the necessity for "specific creations."

CHAPTER XXV.

"VIOLETS BLUE."

FEW of our flowers come with such promise of the nearing summer as the violet! Its euphonious name raises up a host of rich associations as if by magic. The perfume of the first sweet violet of the year greets the nostrils with delightful sadness. There is an odour of dead or far-off friends about it, a faint but impressive remembrance of the shortness of human life, and the fugitive character of human affections. Nothing is more capable of reviving associations of bygone times than the perfumes of familiar garden and other flowers. Strange that most of the secret treasures of the heart should be strung on threads so fragile and yet so endurable!

The *sweet* violet (*Viola odorata*) is the only one of the six English species which has a pronounced perfume. Like the daffodils, it comes "before the swallow dares, and takes the winds of March with beauty." Peeping from beneath the scanty green leaves which have sheltered the flowers from the storms and frosts of January and February, the violet raises its "nodding head," and scents the passing breeze with an odour that causes even a careless passer-by to pause. Later on the blue flowers will have faded away, and the dark green leaves have grown thick and rank, so as to completely hide from any but a botanist's eye the strange fact, not long known, that a second crop of flowers is borne by the same plant,—flowers that never open, and that are mere abortions and monstrosities compared with the "violets blue" of which so many poets have sung!

The extensive geographical distribution of the sweet violet has won for it a place in the poetry of every nation in Europe, ancient and modern. It was one of the devices of Athens when in the glory of her art-civilisation, and was sold in the market-place of that city as it is now in those of our modern towns. It was believed that Diana transformed Io, the daughter of Midas and the betrothed of Atys, into a violet, to conceal her from Apollo. And again it was said that Jove caused the sweet violets to spring up as food for Io, when, under the form of a white heifer, she was hiding from the jealous anger of Juno. Among the Romans the gardens of Pæstum were purple with banks of this favourite flower. That epicurean people degraded the sweet petals into the manufacture of "violet wine." Arab and Persian alike, in the extreme fondness of the Oriental mind for flowers, sang the praises of the sweet violet. In the far-famed "gardens of Gul" it disputed with the luxuriant rose for supremacy. Mahomet declared that the excellence of the violet was as the excellence of El Islam above all other religions; and an Arabian poet, Ebu Abrumi, likened the weeping blue eyes of the fair to violets bathed in dew! This reminds us of one of the many choice references of Shakespeare to our most attractive flowers :—

> "Violets, dim,
> But sweeter than the lids of Juno's eyes,
> Or Cytherea's breath."

Elizabeth Browning also says :—

> "Dear violets, you liken to
> The kindest eyes that look on you
> Without a thought disloyal."

Perhaps one of the most beautiful passages in the works of our great national poet is that which refers, in the "Twelfth Night," to this much admired flower :—

> "That strain again; it had a dying fall:
> Oh, it came o'er my ear like the sweet south,
> That breathes upon a bank of violets,
> Stealing and giving odour!"

The violet has long been employed, in the vague "language of flowers," to express "modesty." Moore speaks of one who

> "Steals timidly away,
> Shrinking, as violets do in summer's ray."

Keats, perhaps, brings home to us most nearly and vividly the bonny spots

> "Where violet beds were nestling."

Barry Cornwall speaks of it as possessing

> "A scent as though love, for its dower,
> Had on it all his odorous arrows tossed."

The same poet also says,

> "I love, how much I love, the rose,
> On whose soft lips the south wind blows
> In pretty, amorous threat,—
> The lily, paler than the moon,
> The odorous, wondrous world of June,
> Yet more—the violet!"

In Beaumont and Fletcher's "Queen of Corinth," we have this flower suggesting the following beautiful passage:—

> "Weep no more, nor sigh, nor grieve,
> Sorrow calls no time that's gone;
> Violets plucked, the sweetest rain
> Makes not fresh nor grow again."

In the old ballad of the "Order of Friars Grey," we have nearly a similar verse:—

"Weep no more, lady, weep no more,
Thy sorrow is in vain;
For violets plucked, the sweetest showers
Will ne'er make grow again!"

In his deep-hearted love for nature, the poet who has immortalised so many of our common flowers was not likely to ignore the violet. Thus we find Wordsworth refers to it as follows:—

"A violet by a mossy stone
Half hidden from the eye,
Fair as a star, when only one
Is shining in the sky."

The strange memories which the perfume of this and other familiar flowers can suddenly evoke was not unnoticed by Shelley:—

"Odours, when sweet violets sicken,
Live within the sense they quicken."

L. E. L., whose poems so delighted the past generation, tells us that

"No flowers grew in the vale,
Kissed by the dew, wooed by the gale,—
None, by the dew of the twilight wet,
So sweet as the deep-blue violet."

And, referring to that better understood circulation of matter and its transformation successively into myriads of organic objects, Tennyson suggests of his friend, that

"From his ashes may be made
The violets of his native land."

Singularly enough, the name of violet is now limited to the flowers of one genus, but formerly many other sweet-smelling flowers went by that name, and we still have certain plants into whose popular name the word enters, as the Water-violet, which is a member of the Primroses.

Scarcely has the sweet violet passed away before it is succeeded by the Dog-Violet (*Viola canina*), a species with lighter-blue flowers and smaller leaves, which makes glad the grassy banks of our country lanes. This is one of our most abundant early-summer flowers. Unlike that of which we have been speaking, it is inodorous; but its quiet, modest, light-blue petals are prominent enough to attract insects, notwithstanding the absence of perfume. Its stalks are longer, and therefore the flower rises into greater prominence than do those of the sweet violet, whose perfume is frequently the only clue to its whereabouts. Both these violets have double sets of flowers,—those which are so familiar, and a later flowering kind, so abnormally constructed that they seem scarcely to deserve the name. Within the last few years botanists have discovered many species of flowers, belonging to widely-different orders, in which these double sets of floral organs are produced. In the sweet violet we find the later kind growing at the base of the dense green leaves. They resemble very early violet buds, and have short stalks. These are genuine flowers, in spite of their plainness and simplicity of structure—flowers that never open, but always remain closed. The parts of the calyx close over and enfold the pistils and stamens present within, and which are the only parts of these queer-looking flowers that answer to the corresponding organs of the more familiar and attractive kind. The stamens ripen their pollen, and the pistil of the same flower receives it, without the external parts opening to the sun or being raised an inch above the base of the root. Self-fertilisation is enough to propagate the species; and so, as is usual in the economy of nature, there is no necessity to don those colours and perfumes which we have already seen are so many bids for the services of insects when crossing is necessary. This kind of aborted flowers is termed *cleistogamous*, from the Greek words which signify that fertilisation is effected within unopened flowers. Singularly enough, in the common Sweet and Dog Violets, it is these closed flowers which bear the most seeds; they are the "workers," whilst the traditional violets seem to be of less account. Lubbock believes that the latter are of use in securing an occasional cross. It is very certain that the blue flowers of the dog-violet produce numerous seeds, and it remains to be seen whether there is not some interchange between these double-flowering plants like that which exists among many of the zoophytes.

These closed violets bear evidence of what may be called "degradation." They have "fallen from their high estate" as attractive flowers. Evidences of their former grandeur are still in part retained within the bud-like form. As we carefully open them, we see traces of the petals, partly coloured sometimes, although wondrously contrasted both in that respect and in size, from their earlier and more richly attired brethren. They represent the first stages in the development of true violets, only that, whilst the process goes on as regards the stamens and pistils, the petals are arrested, and never develop beyond this crude and rudimentary condition.

Whilst speaking of violets, those who have seen the mountain species, the beautiful Yellow violet (*Viola lutea*), sometimes growing so abundantly as to give a golden sheen to the hill-sides, will not be ready to hear it spoken of contemptuously. We have no simpler, prettier, lovelier flower. The Tri-coloured violet (*Viola tricolor*), whose triple tints earned for it in olden times the name of "Herb Trinity," is another species of this lovely group, common in our meadows and lanes in the early summer time. Few people, who briefly notice its meek corolla, imagine that the somewhat gaudy and always showy pansies of our gardens are descended from it and another equally unobtrusive species. It is one of the oldest of our cultivated forms, and in olden times was better known as "heart's-ease." The French name "pansy" has long been in use, however, as we see from the reference to it in "Hamlet;" "There are pansies; that's for thoughts." In the language of flowers it is supposed to mean "think of me;" hence *pensée*. Many of our olden poets refer to this violet both under its French and English names. Milton speaks of the

> "Pansy freaked with jet;"

and Ben Jonson shows how

> "The shining meads
> Do boast the paunce, the lily, and the rose."

Like a true Saxon, John Bunyan scorned to use the French name. In the second part to the *Pilgrim's Progress* he makes the guide tell Christiana that the boy who is seen singing beside his sheep "wears more of the herb called 'heart's-ease' in his bosom than he that is clothed in silk and purple!" The pansy was one of the flowers that cheered poor Leigh Hunt during his undeserved imprisonment, a pot of it having been presented to him. Hence we are not surprised at his referring to this flower in more than one of his poems:—

> "And, as proud as all of them
> Bound in one, the garden's gem,
> Heart's-ease, like a gallant bold
> In his cloth of purple and gold."

Bentham says that the pansy is the only one of our English species of violet in which the showy flowers generally bear seed; but we have already seen that the Dog-violet bears a considerable number. The seed-capsule splits in three parts, and the seeds are thus shaken out by the act of rupturing. The so-called "spur," which all violet flowers possess, is formed by the lowest petal being prolonged. This, when detached, is seen to sheathe two little hinge-like projections from two of the other petals of the flower. In the Dog-violet the floral mechanism is of a very complicated and ingenious character. The middle petal has a long spur which may be entered from the throat of the open flower. Its entrance, however, is partly closed by the top of the pistil, and partly by two tufts of hairs which project from the neighbouring petals. Some of the stamens are elevated on short threads, whilst two possess a kind of spur which lies within that of the petal already mentioned. The stamens stand close together at their tips, and, with the pistil, thus form and enclose a hollow. The pollen of this violet is very dry, and is therefore easily detached. When the pollen-bags open it drops into the enclosed space. The lower part of the pistil is thin and bent, the upper part being blunt. Hence all the pollen-dust is securely kept within the hollow, until some large insect, such as a bee, forces aside the entrance to the throat and spur, and then all of it is suddenly discharged upon its head. The proceedings are like that of the well-known toy called "Jack-in-the-box." The bee whose head is thus dusted flies to some other violet, and in attempting to enter the mouth brings the pollen-dust at once into contact with the sticky surface of the pistil, and thus unconsciously cross-fertilises it. All this floral machinery of the Dog-violet is constructed so that this end may be successfully brought about.

The relative position of the petals of flowers, as well as of the number, shapes, modifications, and positions of the interior stamens and pistils, have only within the last few years been thoroughly understood. Under the old Linnæan classification it was sufficient to know how many pistils and stamens there were, and it was only in a few plants that the position was noticed to any extent. Now that the doctrine which teaches how the structure of flowers is purely one of adaptation to the mode in which the flowers are self- or cross-fertilised, whether by wind or insects, is getting understood, most of the variations can be clearly interpreted. One of the oldest botanists who devoted considerable time to the investigation of these matters was Sprengel, who wrote about them nearly a century ago. This was in the days of the artificial classification, when no room could be made for such observations to tell on botanical science. It was necessary first to break down this system, and bring in that called the "natural," before due value could be given to them. Sprengel tells us in quaint but pious language the reasons which led to his investigating other than the important floral organs of plants. "I am convinced," he says, "that the wise Author of nature would not have created even a hair in vain." And as a reward, Lubbock tells us how

Sprengel ascertained that in many instances the hairs about the throats of flowers (as in that of the Dog-violet) served to protect the honey from the rain.

It was this long-forgotten and painstaking botanist who pointed out the specialised structure of the Sweet-violet. He showed that the flower bent its head on the stalk to prevent the rain getting into the interior, and so dissolving away the honey which is the bait and attraction for insect visitors. This position of the flower also places the stamens so that the dry pollen can fall into the open space already described. The base of the pistil is purposely thin, so that bees and other insects can easily bend it; whilst there are filmy projections from some of the stamens which overlap the middle stamens, and so keep in the pollen until the position of the pistil, etc., is disturbed by the force of the bee endeavouring to get at the honey in the interior of the flower.

The intimate relationship between the structures, colours, and even shapes of most of our wild flowers, and the mouths of the insects frequenting them, is more intimate than we have hitherto imagined. And the investigations of naturalists are every day extending the number of the most striking parallels and adaptation. The divinity of natural history was never richer, nor more suggestive, than it is at the present time. The less ignorant we are of the life-histories and structures of all living forms, animal as well as vegetable, the less likely shall we be to take fright at any hypothesis which professes to explain their *raison d'être.* It is little less than atheism to have such a weak faith in the Almighty as that a startling theory shall disturb its basis! The mysteries of creation increase with investigation, rather than decrease. How spiritually has John Keble made the violet and its companion flowers preach the most eloquent of sermons :—

"The loveliest flowers the closest cling to earth,
And they first feel the sun: so violets blue;
So the soft star-like primrose drenched in dew,
The happiest of spring's happy, fragrant birth.
To gentlest touches sweetest tones reply.
Still humbleness with her low-breathèd voice
Can steal o'er man's proud heart, and win his choice
From earth to heaven, with mightier witchery
Than eloquence or wisdom e'er could own.
Bloom on then in your shade, contented bloom,
Sweet flowers, nor deem yourselves to all unknown;
Heaven knows you, by whose gales and dews ye thrive;
They know, who one day for their altered doom
Shall thank you, taught by you to abase themselves and live."

CHAPTER XXVI.

SUMMER MEADOWS.

WHAT a sense of exalted physical life we feel when the glory of the summer is upon us, and the meadows and woods are decked in their richest floral garments. It is a time when a thoughtful man will reflect on how much the unthinking world owes of its best thoughts to flowers. Their influence insinuates itself into our nature in early childhood, and only assumes another form when the cultivation of rare orchids occupies our latter days. Their graceful leaves and beautifully coloured petals furnish us with all that we require in decorative art: our walls are papered, our rooms are carpeted, and our houses and surroundings are crowded with imitations of floral characters. We speak little of them, and are sometimes hardly conscious of their presence; but all of us are influenced in our goings out and comings in by the presence of flowers.

When our meadows have been converted into sheets of yellow by the crowds of buttercups which love them, there is no bonnier sight in the world. Even before the meadows have assumed the deep greenness so delightful to the eye, they are not unfrequently mottled with patches of bright yellow, from the presence of the first buttercup, the little celandine (*Ranunculus ficaria*), which, like the daffodil,

> "Comes before the swallow dares,
> And takes the winds of March with beauty."

The glossy yellow, star-shaped petals of this, one of the most charming of our common wild flowers, look up at us as we tread the grass, as if begging us not to trample upon it. Wordsworth speaks of

> "Buttercups, that will be seen
> Whether we will see or no."

Perhaps no British poet entertained so deep a love for our common flowers as Wordsworth did, and some of his references to them show us how deeply their influence had sunk in his susceptible heart. What is more simply touching than his address to the "Small Celandine," of which we have been speaking?—

"Modest, yet withal an elf,
Bold, and lavish of thyself;
Since we needs must first have met
I have seen thee, high and low,
Thirty years, or more, and yet
'Twas a face I did not know;
Thou hast now, go where I may,
Fifty greetings in a day."

The old name of "swallow herb," which the little celandine once enjoyed, and which undoubtedly was derived from its appearance being made about the time when that bird arrives here,—just as the cuckoo has given its name to other plants,—is now all but extinct. Old Gerarde, who was exceedingly fond of discovering the etymological origin of common plant names, and who did not scruple to invent them if there was no other resource, tells us that the name of "swallow herb" was given to the celandine because country people believed the old swallows used the herb to restore sight to their young, in case the latter became blind! Whatever may have been the origin of the belief, we have met with several illustrations of it in Lancashire and Cheshire, where the poor people have a firm belief in the ophthalmic properties of the celandine.

All the buttercups possess a strong alkaline poison, which is usually dissolved in the juices of the plant. Hence we see, that however numerous the cattle may be in our meadows, none of them crop the buttercups. In some species belonging to the order the poison is extremely powerful, notably so in the Monkshood, which contains it in such a degree that this plant has given its botanical name to it of *Aconite.* Some Indian species of *Ranunculus* yield the poison used by the Sikhs, during the war we carried on with them, to taint the streams where men and horses drank, and thereby caused much suffering and loss of life. We have a great many English species belonging to this very prominent order, some of them being very unlike each other, but all of them possessing this unpleasant acridity to a greater or less degree. To the philosophical botanist buttercups are of great interest, on account of the many changes which are rung upon them, all of which bear more or less reference to that cross-fertilisation by insects which we have already seen is such an important function in plant-life. All of them are beautiful, the commonest species having been referred to frequently by our best writers. Some of them, such as the Columbine and Monkshood, rank among the oldest of our garden flowers, but they have been long since removed from that dignity by their places having been given to gaudier comers from foreign climes. The Larkspur, however, still holds its own as a garden flower, probably on account of the lovely blue of its flowers, and the not less prettily cut and delicate-looking leaves. Perhaps another and a better reason why it still is to be met with in our gardens is the difficulty we have of getting rid of it, for it springs up with a tenacity which can only be forgiven because the larkspur is the prettiest and most harmless of its kind. The Columbine is still found occupying a corner in country cottage gardens; the rich have long since banished it. The Monkshood, notwithstanding its deep indigo-blue flowers, lives a precarious life, for, as we have already said, it is the most dangerous of its tribe. In the old Saxon times it did good service nevertheless, for this plant was used for poisoning and exterminating wolves, hence its other name of "Wolf's Bane," which it bears unto this day.

The *yellow*-flowered species of the large order *Ranunculaceæ* are those to which most poetical reference has been made. Shakespeare calls them "Cuckoo buds of yellow." That notable bird gave its name to a host of English plants: "Cuckoo Pint" (*Arum maculatum*), "Cuckoo-flowers" (*Cardamine pratensis*), etc. In the damp, moist meadows, especially where some sluggish dyke exists, we find extensive masses of the Marsh Marigold (*Caltha palustris*). A gaudier English flower is not to be found. Shakespeare refers to it as the "winking Mary-buds." Notwithstanding the brilliant and glossy yellow of these large flowers, there are no petals. The sepals are coloured instead, and so in that wonderful economy we find in nature, side by side with the most profligate extravagance, there is no necessity for coloured petals, and none exist. At the base of the yellow petals, in most buttercups there is a little nectary which secretes honey, the hospitable reward offered to insects whenever they " make a call." As there are no petals in the Marsh Marigold, and as the duty of attracting insects by their bright colour is thrown upon the sepals or divisions of the calyx, so that of providing for insect guests is delegated to the ovary. The ease with which the different floral organs are made to do this duty is very remarkable. Although all flowers do not possess nectaries, or honey-stores, there can be no doubt that those which have them are benefited by their possession. It is like " having a good account at the bank." Thus, among the different species of the order we are now considering, we find the ordinary buttercups secreting honey at the bases of their petals ; the Peony manufactures it by the sepals ; the *Pulsatilla* refers that duty to its stamens ; whilst we have seen that the Marsh Marigold secretes it in its ovary. Now we are well aware that under cultivation most of the floral organs of flowers lose their differentiated character and sink into a communalistic republic of petals. Stamens, pistil, etc., all are converted into petals, and so we have *double* flowers ! This partly explains the ease with which honey can be secreted by any organ if required. We know further that all these floral parts are only aborted leaves, actually *lower* in organisation than the green leaves of the same plants. A skilled horticulturist can, at will, convert the very young leaf-buds into flower-buds, by simply *crippling* the plant, and not allowing the leaves to reach their higher vegetable life. Hence the dense pyramidal masses of *Azalea* or Camellia, which can so easily be reared in greenhouses. All their wealth of colour has been developed by *impoverishing* the shrubs, not by encouraging their growth.

Truly the poet's remark can only be applied to our English meadows, where

> " The buttercups across the mead
> Make sunshine rift of splendour."

The species which is most abundant is the Upright summer buttercup (*Ranunculus acris*). It is one of the most bitter and disagreeable to the taste, and cattle therefore persistently refuse to eat it. Perhaps the same meadows are occupied by another species, the Creeping Crowfoot or buttercup (*Ranunculus repens*), which may easily be distinguished by its having root-runners like the strawberry. Hence it has a double advantage over its fellows, for it propagates its kind by shoots as well as by seeds. We have here operations very similar to those exhibited by such animals as the sea-anemone and the common freshwater hydra, which bring forth young from eggs, as well as from *fission*, or budding. Before the last species of buttercup burst into blossom, its place had been occupied in the same meadows by the Bulbous Buttercup (*Ranunculus tuberosus*). This is the first to appear, even before the little celandine has passed entirely away. The sepals of the calyx are nearly as yellow as the petals themselves, and are reflected or bent backwards, so that the species may be easily recognised by this feature alone. The base of the stem swells into a bulb-like expansion, which contains an extremely acrid, starchy matter. In some places these are known by the name of " St. Anthony's turnips." The summer buttercups have a peculiar and simple arrangement, by means of which crossing can be brought about. The anthers, or " pollen-bags," which are borne on the ends of the stamens, begin to discharge their pollen as soon as the flower opens. The outside row of the numerous stamens open first, then the next, and so on in turn. Meantime the pistils of the same flower are immature, so that all the pollen discharged must necessarily be carried off to other flowers by the insects which will not fail to visit it. At length the pistils are ripe, and by this time the inner and last rows of stamens are opening. Hence, if the pistils be not crossed, there is pollen enough left from the adjacent stamens to produce self-fertilisation. As a rule, however, Lubbock has shown that the pollen from younger flowers is usually carried by insects to cross the older ones with.

It is these various species of buttercups, or " crowfoot," as they are also called, which also rejoice in the olden name of " Kingcups." Every English country boy has plucked them, and held them mysteriously to his own or his companions' chin, to "see which liked butter best!" There are few who cannot say of them, with Campbell,

> "Wildlings of nature, I dote upon you;
> For ye waft me to summers of old,
> When the earth teemed around me with fairy delight,
> And when daisies and buttercups gladdened my sight,
> Like treasures of silver and gold.
> Earth's cultureless buds! to my heart were you dear
> Ere the fever of passion, or ague of fear,
> Had scathed my existence's bloom;
> Once I welcomed you more, in life's passionless stage,
> With the visions of youth to revisit my age,
> And I wish you to grow on my tomb."

What a strange wailing is this of the human soul after the past or the future,—a restless discontent with the present, so that "man never is, but always to be, blest"! What frail and tender objects suggest the fact that "here we have no abiding city"! The flowers and the birds are the joyous companions of our earthly pilgrimage, but they leave us on this side the "dark river." We are thankful for their association so far, and still more so for the rich wealth of associations, dearer still, of dead friends and loved ones, to whom the grasshopper has long ceased to be a burden, and who no longer

> "Hear the nightingale
> Sing on, as if in pain."

Eliza Cook speaks of lingering

> "Latest on the spot where buttercups are found."

The same poet frequently refers to the rich and tender associations which flowers possess, and refers to the bouquets of buttercups and daisies which English children invariably form together, as follows :—

> " I never see a young hand hold
> The starry bunch of white and gold,
> But something fresh and warm will start
> About the region of my heart."

Robert Browning also speaks of buttercups as the "little children's dower." And thus all our poets have continued to regard them as specially the flowers with which the pleasures and pains of childhood are so connected that we cannot dissever them.

Even more showy than the gaudy flowers of the Marsh Marigold are the less pronounced but prettier, large, round corollas of the rarer globe flower (*Trollius europæus*), which poor Charles Kingsley has immortalised in "Two Years Ago," as growing on the flanks of Snowdon. Those who have seen it growing in dense luxuriance in the copses which fringe Lake Windermere, in the months of June and July, will not speedily forget it. So pleasing is the pale yellow of this flower, that it is one of the few of our native wildlings we have transferred to our gardens. The Scotch call it the "lucken gowan."

What are those shiny white flowers forming such a bright carpet over the tarns with which our green meadows are so frequently besprinkled ? The idler may unwittingly have been attracted to some such spot hidden away by the tall, unmown grass, and known only to the water-hen and her young: if so, he has seen these white flowers, which belong to the Water-crowfoot (*Ranunculus aquatilis*). Like many of our native water-plants, they have two sets of leaves, —one set composed of small, thread-like parts, which are always immersed in the water; the other and upper of roundish, lobed leaves, of a prettily-cut pattern, which are the "floating leaves" that buoy up this charming flower and enable it to "rejoice in the sun." The surface of the tarn is covered with other aquatic plants, that are silently wrestling with and elbowing each other for room, and sunshine, and air. The framework or setting of the tarn is a dense mass of carices, irises, catstails, bullrushes, meadow-sweet, purple loosestrife, figworts, forget-me-nots, red campions, and spearworts. How the evening wind sighs and soughs through them, as though the place was haunted! The plunge of a water-vole or the croak of a frog seems to intensify the silence which can then so painfully be felt. A score of unassignable sounds succeed each other as the twilight graduates into night. But in the summer's mid-day how laughingly the same quiet tarn seems to upbear its burden of varied life! The breeze chafes the margined plants against each other, as if in pleasant rivalry; the spangled blue and green dragonflies flit in uncertain shifts hither and thither, taunting one's eye with the hope they are about to alight; the open flowers look up at us with their bold eyes; the water-hens plunge here and thither in secure concealment. What an abundance of life-forms, animal and vegetable, can one little spot like this in God's world afford to maintain!

In such a fringe of water-loving plants the Spear-worts (*Ranunculus flammula* and *lingua*) will be surely more or less abundant, their small yellow flowers looking conspicuously out of their linear and spoon-shaped leaves. Perhaps, too, here we may find the celery-leaved buttercup (*Ranunculus sceleratus*) more acrid than any other. Its leaves are like those of the common celery, and will be found growing nearest the water's edge.

Time and space forbid us to note many English plants which are buttercups and yet not buttercups. The order *Ranunculaceæ* includes a great many species we should never imagine had any affinity whatever with the flowers we have been speaking of. Such are the Clematis and Meadow-rue or *Thalictrum*. The last is like a buttercup from which the sepals and petals have been plucked, leaving only the showy long stamens and pistils,—indeed it hardly possesses either of those ordinary floral envelopes. It may easily be recognised by its elegant rue-like leaves. The Anemone, Hellebore, Aconite, Larkspur, Columbine, Monkshood, Hepaticum, and Peony are all first cousins to the common buttercups. To the botanist many of them are especially interesting. He sees in the Monkshood the sepals of the calyx deeply coloured and the inclosed petals degraded from their usual floral estate into small and inconspicuous nectary-bearers; in the Larkspur he notices how one of the coloured sepals is prolonged into the "spur" in which is a wonderful bit of machinery formed by the aborted and diminished petals to ensure cross-fertilisation by the agency of any insect that attempts to get at the honey stored up in the spur; in the Columbine he observes how *all* the sepals are equally spurred, and not one only as the Larkspur: everywhere the same *fact* strikes him of the complexity and yet the basal simplicity of floral structures.

CHAPTER XXVII.

HEDGE GARLANDS.

AT no time of the year do our country hedges look so charming as in early June. The unfrequented green lanes are lined with banks of flowers, whose bright colours and sweet perfumes make the morning air more delicious than fabled nectar. The atmosphere thrills with the loud concert of bird-music, softened by the hum of insect life. The fleecy clouds hanging in the laughing blue sky seem as if they joined in the festival of joy on which they look down! All animated nature seems to be holidaying, and the Lord of Life is spreading a table even in the wilderness! The sparkling dew-drops fill the chalices of wild flowers, so that they look like beauty smiling through tears. Perhaps this is the month of all the year when the tide of mere physical life is at its height. We feel what a joy it is merely to live!

Our hedgerows are then unequalled for beauty: the fresh green hawthorn leaves have not been devoured by caterpillars, but look crisp and strong, with just a reddish tint where the young shoots are rapidly sprouting upwards, and expenditure of energy is taking place. The blossoms of this useful and common shrub are unsurpassed by any of our wild flowers; and we see them bursting forth in rich broken masses of pure white, and filling the air with fragrant and suggestive odour. The movements of the small birds as they spring from twig to twig, scattering the loosened petals, cause jets of fresh hawthorn scent to rise and greet the nostrils with unexpected delight. How one longs, when far away from England, for a sight and smell of the hawthorn blossoms! How we miss the familiar and too geometrical parcelling out of fields by hawthorn fences when travelling in other lands. This shrub clings to and characterises the scenery of England like the language; and perhaps both were introduced by the same Saxon settlers. It is surprising how largely the latter utilised the hawthorn, both as a defence and an enclosure; and its name actually enters into and often forms a part of many of those very English villages which it still adorns so beautifully! From earliest times it has been one of our favourite shrubs, and its blossoms have been cherished both for their rich perfumed beauty, and as the first-fruits of the early summer. The ancient Greeks and Romans regarded it with favour, although it could neither have been so common, nor have been so mixed up with their everyday life as it is with our own. Among the latter, sprigs and branches of hawthorn in blossom were largely used during marriage feasts. Chaucer, who had a keen and loving eye for common English flowers, has not failed either to notice the hawthorn bloom, or to put on record the happy associations with which its gathering had even then been surrounded.

> "Furth goth all the Courte, both most and least,
> To fetch the flowris freshe, and braunche and blome.
> And namely hawthorne brought both page and grome,
> With freshe garlandis partly blew and white,
> And then rejoisin in their grete delight."

The practice of going out in the early dewy morning to gather the hawthorn blossoms was kept up even in the time of Henry the Eighth, and undoubtedly had been so more or less, since Chaucer had referred to it as above. Eventually the custom passed away from older folk, and survived only among children. Thus Spencer speaks of hawthorn collecting in his "Shepherd's Calendar," as being in this stage :—

"Youth's folk now flocken everywhere,
To gather May-baskets and smelling breere,
And home they hasten the posts to dight,
And all the kirk-pillars ere day-light,
With hawthorn buds, and sweet eglantine,
And garlands of roses, and sops-in-wine."

Herrick was not likely to overlook such a floral custom, with the keen love he had for flowers and their associations, and so we find him addressing "Corinna" thus :—

"Get up, get up, for shame : the blooming morn
Upon her wings presents the god unshorn.
See how Aurora throws her fair
Fresh-quilted colours through the air ;
Get up, sweet slug-a-bed, and see
The dew besparkling herb and tree.
Each flower has wept and bowed towards the east
Above an hour since, yet you are not drest,
Nay, not so much as out of bed !
When all the birds have matins said,
And sung their thankful hymns, 'tis sin,
Nay, profanation, to keep in ;
When as a thousand virgins on this day
Spring sooner than the lark to fetch in May."

By its name of "May" the hawthorn is still best known in the Eastern counties, although its flowering is more distinctive of June than the month whose name it bears, owing to the change in the calendar. Chaucer seems to have hesitated as to which flower he loved best, this or the daisy. Thus we find him saying—

"Among the many buds proclaiming May
(Decking the meadows in holiday array,
Striving who shall surpass in bravery),
Mark the fair blooming of the hawthorn-tree;
Who, finely clothed in a robe of white,
Feeds full the wanton eye with May's delight,
Yet for the bravery that she is in
Doth neither handle card nor wheel to spin,
Nor changeth robes but twice; is never seen
In other colours than in white or green."

Shakespeare makes this common shrub point one of his beautiful morals:—

"Gives not the hawthorn-bush a sweeter shade
To shepherds, looking on their silly sheep,
Than doth a rich-embroidered canopy
To kings?"

We have some famous and even historical "Thorns;" whilst once every village had its shrub, famous for size, such as Goldsmith refers to in his "Traveller:"—

"The hawthorn-bush, with seats beneath the shade,
For talking age and whispering lovers made."

When the traditional "May-pole" was reared, it was always held necessary to crown it with a huge branch of hawthorn blossom. Every European country seems to have cherished traditions concerning this widely distributed tree, although none of them appear to have been so lovingly preserved as in England. Solitary hawthorn-trees were formerly believed to be specially cared for by the fairies. They were the trysting-places of the "little folk," and cursed be the boor who durst so much as pluck a leaf from such a tree! No ghost, even, durst approach them! The early Catholics believed that it was of the hawthorn that the "crown of thorns" was made, and therefore, says quaint Sir John Maundeville, "hath the white-thorn many virtues. For he that beareth a branch on him thereof, no thunder, or manner of tempest may hurt him; and in the house that it is in may no evil ghost enter." It was probably this belief that led to the adornment of churches with the hawthorn, on the same principle as that which caused them to paint the figure of St. Christopher opposite the north entrance, in order that evil spirits might leave those who looked upon it as they entered in.

The famous Glastonbury white-thorn, said to have sprouted from the staff which Joseph of Arimathea planted in the ground, is a good illustration of how explanations were formerly given. It is not unfrequent for some shrubs or trees to flower twice in the year. Young cherry-trees frequently do this, as well as others; such as the elder, dog-wood, apple, and pear. The original thorn which gave rise to the tradition is said to have been cut down by a Puritan soldier of the Commonwealth, who regarded it as an emblem of Popery. The belief was that it was always in flower on Christmas Day, and not before. A good many sprigs of this famous thorn had been planted before the destruction of the parent tree, and, singularly enough, nearly all have inherited the double-flowering habit. Last December (a week or two before Christmas Day) we received a sprig, on which were both leaves and blossoms. Herefordshire, Lancashire, Suffolk, Worcester, Kent, and other places, have several "holy thorns" which possess this double or winter-flowering habit; but it is certain that all are not descended from that at Glastonbury. In the old superstitious days, the common folk believed in the medicinal and other virtues of these strange flowering trees, although not in the Popish legends which accounted for their winter blossoming; and even the wealthy gave large sums of money for cuttings from such, so that they might be planted in their own grounds.

The hawthorn seems to be more sensitive than many other hard-wooded trees. Thus, those grown on clayey soils have often pink or red flowers. Even the white snowy masses of the ordinary shrub, especially after a wet week, become deeply pinkish before fading. This red variety has been selected and cultivated for ornamental purposes, and is now one of the most showy shrubs of our plantations. A further change has also been successfully carried on in the pink and red hawthorn blossoms. The pink stamens, which stand out so prominently in the centre of the natural white flowers, are developed into true petals, and thus a great many of our red hawthorn-trees have *double* flowers. In such cases propagation has always to be performed by planting shoots from the parent trees, as no "haws" are produced. Speaking of these haws, which give their name to the plant, what can be more beautiful than their thick scarlet clusters, just before the faded yellow and red leaves fall to the ground? Country folk still believe what evidently men of science thought about them three hundred years ago: viz., that when they are abundant a severe winter is sure to follow. Lord Bacon remarked that "a store of haws portends cold winters;" and it was argued that the fruit was a purposely stored-up provision for the birds against the time when the snow covers the ground. There can now be little doubt that all bright coloured fruits attract birds, just as conspicuous flowers attract insects, for it is by bird agency that their seeds are dispersed.

The delightful hum we may hear the whole livelong day, whilst the hawthorn blossoms last, is due to the numerous insect tribes which are aware that at the base of the petals there is a small store of honey. The well-known peculiar perfume is like the odour of bitter almonds, and is chemically due to the same source,—the presence of a small quantity of what is popularly termed "prussic acid" in them. Many other flowers which belong to the same order (*Rosaceæ*) as the hawthorn possess this almond perfume, and it is strongest of all in one of them,—the common meadow-sweet,—to be found in abundance by the sides of moist and damp ditches.

Before the hawthorn shall have ceased flowering, the honeysuckle will have flung its tough wiry branches around, and clasped it after the strangely spiral fashion which has earned for this plant its other name of "woodbine." Although not stout enough to raise and bear itself aloft by means of its own stem, the ease with which it can entwine around other plants enables it to grow even higher than they. The honeysuckle is as well marked and beloved a feature in our English green lanes as the hedgerows themselves. It clusters round the humble cottage homes, and adorns their unpretending porches with its familiar flowers. The atmosphere is laden with its heavy perfume, especially when evening falls, for the honeysuckle is especially a night-flowering plant. So common and yet so attractive a shrub could not fail to be beloved by British poets. Singularly enough, Milton falls into the mistake of calling it "the twisted *eglantine;*" whereas the name of "eglantine" belongs to the sweet brier! Scott has introduced it in one of his poems:

> "The lonely infant knew
> Recesses where the wall-flower grew,
> And honeysuckle loved to crawl
> Up the lone crag and ruined wall.
> I deemed such nooks the sweetest shade
> The sun in all his round surveyed."

More in keeping with the habit of the honeysuckle is the reference made to it by Shakespeare.

We may yet find thousands of such banks as that he mentions in his "Midsummer Night's Dream:"

> "I know a bank whereon the wild thyme blows,
> Where oxlips and the nodding violet grows;
> Quite over-canopied with lush woodbine."

Shelley mentions such another spot:

> "I dreamed that as I wandered by the way,
> Bare winter suddenly was changed to spring,
> And gentle odours led my steps astray,
> Mixed with the sound of waters murmuring
> Along a sheltering bank of turf, which lay
> Under a copse.
> * * * *
> "And in the warm hedge grew lush eglantine,
> Green cowbine and the moonlight coloured May,
> And cherry blossoms, and white cups, whose wine
> Was the bright dew yet drained not by day."

Keats's delicious description of the honeysuckle is one of the many proofs we have of the keen love he had for all natural objects. He speaks of the

> "Dew-sweet eglantine,
> And honeysuckles full of clear bee-wine."

We know now how full of botanical truth is this. The long tubes of these flowers contain more honey than the corollas of any other species of British flowers. And the reason why the deep perfume of the honeysuckle is given forth in greater richness when evening draws on and the damp night air is better fitted to carry odours, is that certain moths may be attracted to it. The long flower tube is nearly half full of honey, but it is still so far down that ordinary insects cannot reach the much-prized nectar. Only certain moths, possessed of extraordinary long proboscides, which can be coiled up and uncoiled at pleasure, can obtain the singularly hidden treasure. These moths go by the name of *Sphinxes.* They differ from other moths, not only in the much greater length of their proboscis, but also in the shape and size of their wings, which are narrow and very long, so as to enable their possessor to hover in one spot for a length of time, whilst the long trunk is thrust down one honeysuckle flower after another in search of the sweets. In this respect they resemble the humming birds among the feathered tribes, which can hover above flowers and sip their honey by means of their long and flexible tongues. Indeed one of their number is so like these diminutive birds, both in shape and habit, that it is called the " Humming-Bird Hawk-Moth."

We have two native species of honeysuckle (*Lonicera caprifolium* and *L. periclymenum*). The former may be known by its distinct leaves, the upper ones of which meet in opposite pairs which seem so joined at the base as to surround the stem. Such a leaf-arrangement is well termed *perfoliate.* Its flowers are especially adapted for visitation by the larger moths. This species, however, is not by any means so common as the latter, and indeed many botanists think it can hardly lay claim to being considered native. The flowers are usually in whorls, whilst those of the common honeysuckle are in terminal clusters. Bees are said to be able to get at the honey in the last-mentioned species, owing to the flower-tubes being shorter than in the former ; so that Keats's name of "bee-wine," for the contained nectar, is more or less botanically and zoologically true. This rich store of perfume and honey is a reward for the insect diligence expended in crossing the flowers, and without which we should lack the clusters of tempting scarlet berries with which the honeysuckle adorns our hedges in the late autumn time. Notwithstanding the wiry and seemingly awry mode of growth which the honeysuckle affects, it is obedient to a non-understood law which dictates that it shall, more or less persistently, twine from left to right.

> "With clasping tendrils it invests the branch,
> Else unadorned, with many a gay festoon
> And fragrant chaplet, recompensing well
> The strength it borrows with the grace it lends."

A humble poet says truthfully of this national favourite :—

> "By rustic seat and garden bower,
> There's not a leaf, or shrub, or flower,
> Blossom or bush, so sweet as thee,
> Lovely but fragrant honey-tree.
> By stately hall we see thee not,
> But find thee near the lowly cot,

Or lattice-porch ; by humble door
Thou leanest with thy honied store,
Dropping from thy bebosomed flowers
Sweetness through evening's dewy hours.
Tree of the cottage and the poor,
Can palace of the rich have more !"

We have spoken of only two kinds of the commonest objects in our country walks, and behold how the tenderest thoughts of men and women have gathered around them! Flowers are the ministering angels of poetry, and the charms of colour and perfume are in very truth the love-songs of the plants. How often do they come with humanising influence upon all of us! Few there are who never felt the overpowering loveliness of the world, when familiar perfumes of some common flowers have greeted the nostril. An escaped sigh has often unconsciously been uttered when floral influence has been as unconsciously exerted, and it may be that even such a feeble incident as this has been a "ministering angel," relieving the oppressed spirit, and escaping with a burden of trouble! The true "language of flowers" yet remains to be written. It consists not of the silly sentiment which is usually made to represent it, but is like that of the stars, which "day unto day utter speech." Like them, their language has "gone forth to the ends of the earth," and the best and purest sons of humanity have been lifted heavenward by its unuttered eloquence.

Flowers have been made to symbolise human feelings and affections more than any other group of natural objects. The wisest men in all ages and climes have availed themselves of their ready suggestion; and even He, "who spake as never man spake," did not disdain to point some of the highest morals of Inspiration by a reference to the "lilies of the field"!

THE END.

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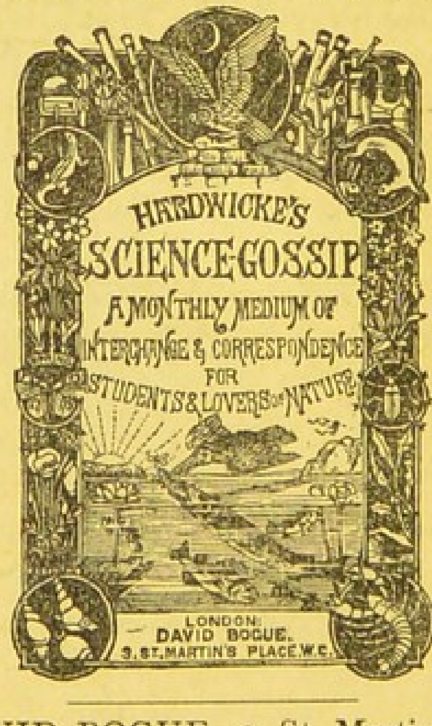

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