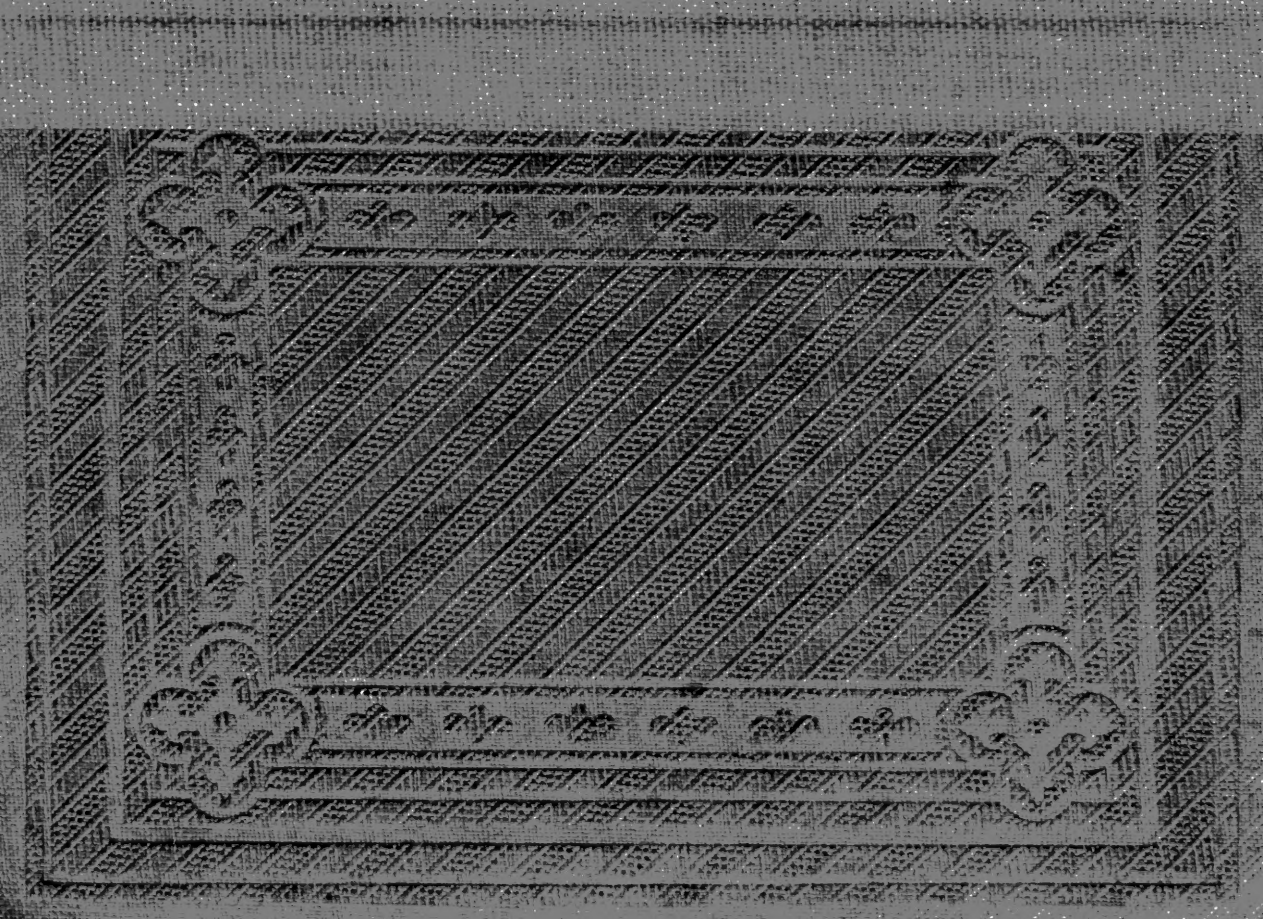

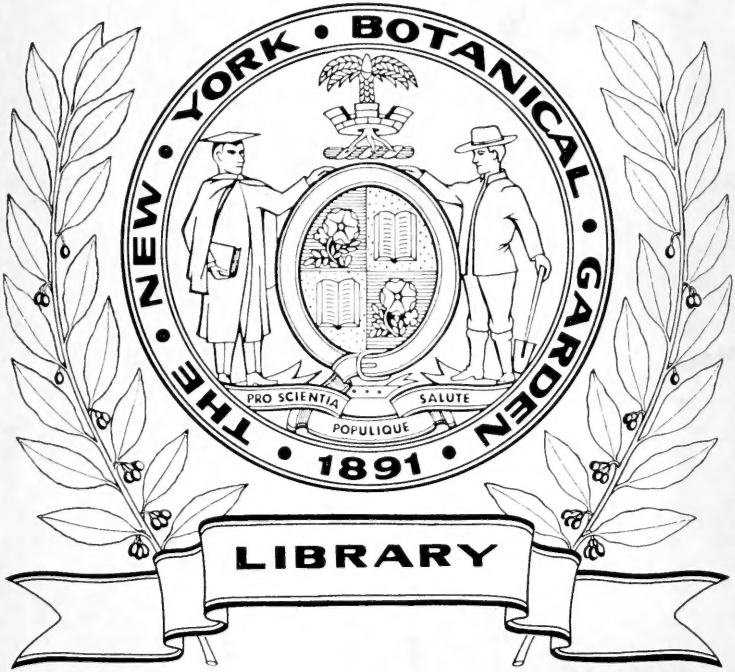
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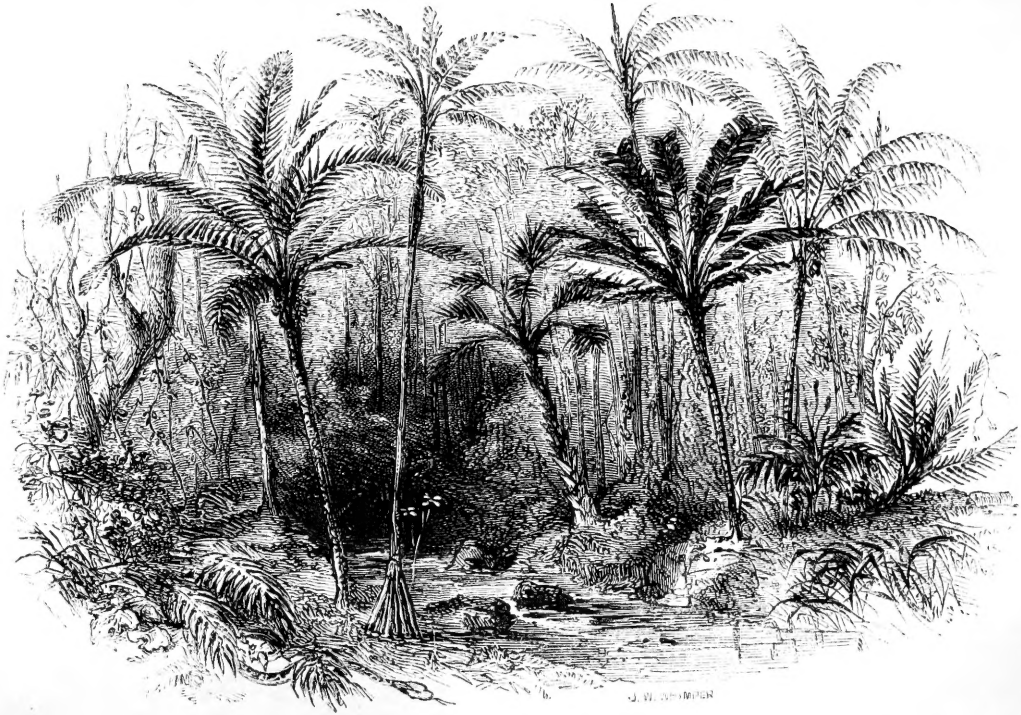

SCENE IN A BRAZILIAN FOREST.

THE

LIFE OF A TREE;

BEING A

HISTORY OF THE PHENOMENA OF VEGETATION

FROM THE

SEED TO THE DEATH OF THE PLANT.

PUBLISHED UNDER THE DIRECTION OF THE
COMMITTEE OF GENERAL LITERATURE AND EDUCATION,
APPOINTED BY THE SOCIETY FOR PROMOTING
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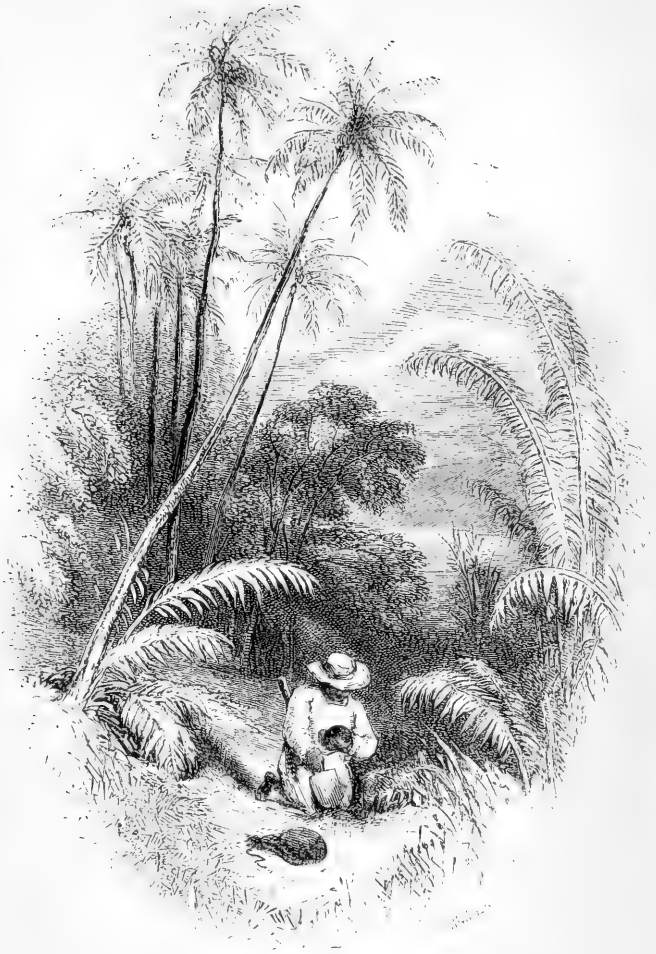

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THE INFANCY OF A TREE.

THE LIFE OF A TREE.

CHAPTER I.

THE INFANCY OF A PLANT.

WHERE shall we place the cradle of vegetable life? Shall I take the reader to the dim shades of a Brazilian wood, and, by the side of one of those broad rivers which roll their life-teeming waters steadily down through thousands of miles of vegetable luxuriance, point to the ripe berry just dropped into the soft mud, and almost while we are looking on, coming to life, and shooting up into a great plant? Shall I take him to some palm-crowned isle, and, standing on a coral-reef, bid him watch the long swell of the great Pacific, carrying on its crest a solitary coco-nut,

leave it on the white shore and retire again; while from the one end of the sea-washed fruit presently peeps out a lusty shoot,—and ere our next visit, behold! a great tree, itself laden with fruit, occupying its place? Or shall we travel to the parched Sahara, and mark that tumbling wind-tossed ball, like dried parchment, which, wandering hither and thither at the will of the hot and fitful wind, alights at length on a spot where some sweet drops of refreshing moisture ooze up through the thirsting soil; and, while the hour remains, see it unfold its horny bosom, and jut out buds and flowers? Or hence take the wind's wings and seek the snow-covered, ice-bound plains of the North, and here behold—are they spots of blood? —here and there, far as the eye can reach, deep crimson stains lie on the pale surface. Has some giant animal received his death-wound, and, in his painful staggerings to his lair to die, let fall a thousand drops of blood? Whence come these gory marks, so thickly scattered as if the sky itself, deep, clear, and cold as it is, had been weeping tears of blood? A handful of the crimsoned snow answers the question, and by the microscope informs us that the stain is due

to the presence of a multitude of minute cells, which, bursting, scatter around more cells, and these more again. This is a plant; and here too, if we choose, might we watch the birth of vegetable life.

Since then, the birth-place of the seed is so various, since it is the order of Nature and indeed the custom of man, to assign differences of locality, and differences of external conditions, to the early homes of vegetables, we may find interesting matter for a little thought in examining these circumstances in brief, ere we look at life's beginnings in the seed itself. We may look upon the earth as a great garden, in the countless plots of which millions of plants and trees live and die in a variety of conditions, all of which deserve our attention, although only a few, and these very imperfectly, can obtain room in this little work. In an ordinary flower-garden it is well known that different seeds demand different treatment: some may be cast upon the surface, and left to take their course; others must be watched, nurtured, and tended with the utmost care; some require heat, others do not; and some require much moisture, while others will be con-

tent with very little. So is it in the wide garden of the world: the constitution of plants varies, and their conditions of coming into existence vary also.

Let us, then, cast one glance abroad.—We are in Ceylon. The blue and cloudless air is full of warm odours, and the burning sun drives us to the shelter of the coco-palm groves. Here comes a native with a rude kind of spade in his hand, and a bag containing salt together with a coco-nut in the other.* Digging about a foot down into the soil a hole sufficiently large to accommodate the nut, he sprinkles a little salt over it, then shovels in the earth, and setting a mark over the place leaves it. By-and-by the soil cracks, and the young plant rears its head aloft, and in time takes its place with the noblest of those around.—Now we are in Egypt. In the dim horizon see the pointed peak of the pyramids standing against the sky; while between them and Cairo rolls a sea of fertile land, level and smooth; and the great Nile in the distance is seen winding its lazy length along in a serpentine direction toward the sea. The inundation is at an end; the retiring

* See the Frontispiece to this Chapter.

waters have left the whole surface of the country in the condition of a most prolific seed-bed. The Egyptian comes and casts his seed-corn upon the rich compost thus provided for him by the wonderful river; soon, fortified by the warm air and all-day-shining sun, the young plant appears; and but a little while need elapse before we behold the valley standing thick with corn.

Let us turn from hence to the still waters of the Imperial Canal in China. Here, at morning-time, the whole surface of the water appears covered with a dense carpet of green. This effect is produced by the leaves of the water-nut (*Trapa bicornis*), the seeds of which were some time since committed to the waves by the Chinese cultivators. As the sun rises high the fair white flowers open, and the floating carpet now becomes white, interspersed here and there with the tulip-shaped, lovely pink blossoms of the lotus flower. After a few months the nut is ripe, and supplies millions of human beings with sustenance. Here was a plant born in the waves!

Look now at yonder broad Indian plain covered with water. See that pair of bullocks dragging a rude plough behind them, whose share

is buried below the surface of the water, while they and the holder of the plough wade ankle-deep along their toilsome course. Then watch who follows,—one with a number of little balls of earth, out of which peeps a young plant. These are dropped in, the bread is cast upon the waters, and after many days a waving rice-field occupies the place of the formerly unclothed plain.

But nearer home. It is seed-time, and Old England's broad bosom is being ploughed into many a furrow. Along the upland see the pair of well-fed horses steadily pulling the iron plough held by the whistling ploughman, so is the seed-bed laid open. Then see the sower with his basket of corn-seed flinging abroad the precious grain; while the harrow follows him, and gently covers in the seed, imbedding it an inch or two in the soil. Winter follows the steps of the sower, and puts its ice-lock on the ground. But in time the dreary months pass by, the "winter is past, the rain is over and gone, the flowers appear on the earth," the corn blades rise from the brown bosom of the field, the summer's sun gilds the heavy ear with its own golden tint,

and the still evenings of autumn see the laden wagons carry them to the barn.

Thus variously is the seed sown, and in these different and opposite circumstances does plant-life begin.

Now, while it is true that these circumstances are all very different from one another, it is also true that, if we take a little pains to think over them, the differences will not appear as great as they now do. What we require to know is, what is requisite, as far as outward influences are concerned, to start life in the seed. In all the examples mentioned the essential conditions exist, but are greatly modified: nevertheless they exist, and by virtue of their presence the seed begins to live.

These conditions are very simple and easy to be understood; and, as they are only three in number, they deserve to be remembered. They are:—first, a sufficiency of moisture; second, a sufficiency of air; and third, a sufficiency of heat. Thus Water, Air, and Heat, are absolutely necessary to a seed before it can begin to live. And if the reader will glance back over the various examples of seed-sowing we have enu-

merated, and reflect upon them, he will certainly find in all that these three conditions exist:—yes even in the Arctic Regions there is at proper seasons enough heat, moisture, and air for a red-snow plant to live; although it is necessary to mention that its little cells do not properly belong to the class of seeds, and are not so dependent on these external circumstances.

Up to this point we have spoken of the life of a seed as if it only commenced at the time when the first appearance of the little root and the young leaves occurs. But it is interesting to remember, that seeds are actually alive, strictly speaking, before they are committed to the earth; and some very curious particulars belong to this part of vegetable history. In proof of this, let the reader take a handful of wheat and put it into boiling water for a few minutes; then let it be taken out and sown in the earth. They will never spring up; the seeds have been killed.

Some interesting experiments on this subject were made by Messrs. Edwards and Colin. They found that at a degree of heat (125° Fahrenheit's thermometer) which could be borne by the hand

without inconvenience, the tender seeds of barley, kidney-beans, and flax, were killed. At twenty degrees more heat the seeds of wheat were killed, and in still hotter water the death took place almost immediately. Extreme cold is equally destructive to seeds of many kinds, though less so to those just named. From this cause many a florist in England has experienced deep disappointment, in receiving valuable packages of seeds from India, which have travelled by the sea-route. The tender seeds of that burning climate die in consequence of their exposure to great extremes of heat and cold before they can arrive in England. Thus, while we may justly say that the seed slumbers so long as it is in that condition under ordinary circumstances, the sleep is not death, and the beautifully organised mass is only waiting for the voice of Spring, and the scent of water, to put forth its leaves and awake to vigorous existence.

The question, How long may a seed remain in this state of sleep without passing into that of complete death? is one which must receive very variable answers. Certainly the time is limited, but the limits differ in different plants: in

some, death occurs in a few years; but in the following wonderful instances seeds have attained a greater age than twice the life of the oldest man that ever lived. Dr. Lindley says:—"I have before me three plants of raspberries, which have been raised in the garden of the Horticultural Society from seeds taken from the stomach of a man, whose skeleton was found thirty feet below the surface of the earth, at the bottom of a barrow * which was opened near Dorchester. He had been buried with some coins of the Emperor Hadrian, and it is therefore probable that the seeds were *sixteen or seventeen hundred years old!*" Yet, on being planted, and carefully tended, they came to life and bare fruit.

A more remarkable anecdote of the vitality of seeds is related. In the folds of cloth which the ancient Egyptians used to wrap round the bodies of their dead after embalming them, a few grains of wheat were found by an Egyptian traveller. The age of the mummy, as their embalmed body is called, was probably at least from two to three thousand years! This gentle-

* A barrow is an ancient form of hollow underground tomb.

man took care of the seeds, and committed them to the charge of an experienced horticulturist, who planted them. To the amazement of both parties, the seeds proved to be alive; and in a little while, strong, healthy plants of Egyptian corn made their appearance above the soil. These, in due time, ripened, and bare fruit abundantly. The seeds were preserved, and in due time sown, and these also produced healthy plants, and an abundant supply of more seed-corn. Ultimately, enough was obtained to make the seeds an article of sale; and the reader can at this day, if he pleases, purchase for a trifle the descendants of seeds which were, at the very least, two thousand years old before they were committed to the soil. This wheat, from its interesting origin, is called "Mummy wheat."

What a wonderful subject for thought is this! A sleep of two thousand years! And how remarkably does it illustrate the wisdom and providence of God, who has endowed seeds with this length of vitality, to guard against their ever becoming lost to man, as they would soon be if all were not able to endure a life of slumber beyond a year or two.

The seed, in this condition, presents us with a problem science is not yet able satisfactorily to resolve. We cannot tell what its life consists in, yet we know it to be alive; we do not know why its powers should be, as it were, hushed to sleep, and yet still remain in it ready to come to life when outward circumstances are favourable. Neither can we say why, after a certain lapse of time, these powers disappear, and the seed becomes really and truly dead. All this is full of mystery, even to the wisest of men; nor is it probable the difficulties will ever be cleared up by the efforts of human philosophy. The truth is, in this and in many other cases, "*now*, we know only in *part*;" in another life we shall know *all*.

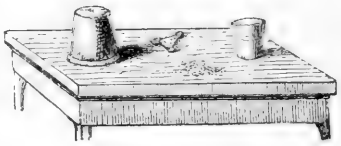
But now we are to suppose the sleep is about to be broken; Nature's husbandmen, the birds, the beasts, and the far-circulating winds, or the human husbandman, have buried the seed in the soft bosom of the earth. The evening dew and morning shower come down, and give to its bed the proper supply of moisture; the warm sunbeam gently heats the earth; and the air creeps in at the chinks, and gives the proper stimulus to the awakening plant. Thus the three essential

points are gained, and under the influence of them the seed commences that wonderful chain of living actions, which are only to cease when the tree becomes dust again.

Sometimes, indeed, the seed need not be first buried in earth before it can awake to life, and become a new and vigorous plant. The most curious instance of this exception to the general rule is in the case of the mangrove, a tree growing exclusively in tropical countries. These trees delight to grow in the soft, oozy mud, where a river enters the sea, and to have their roots continually immersed in the wet and pestiferous waters, half fresh and half salt. If they were to drop their seeds as other trees do, they would fall upon the surface of the waves, and be carried away and lost. But it has been otherwise ordered. The seed begins to grow here before it leaves its parent's breast, and puts out a long delicate root, which lengthens downward until it has reached the mud below; here it strikes root, and as soon as it is strong enough to provide its own living, its connection with the parent-stem is broken off, and it becomes a vigorous tree.

Ordinarily, however, the imbedding in the soil is necessary for the growth of the seed, although it is by no means essential, since many seeds, if merely moistened with a little water, and kept in the dark, and in a room of moderate warmth, will begin to sprout. But they rapidly die if kept out of the earth for any length of time after this process has once begun. Probably every one has heard of the sailor's mustard-and-cress apparatus. Those who have not may be informed that it is simply a *worsted stocking and a bottle:* the seeds are scattered inside the stocking, which is kept extended on the bottle and constantly wetted; and in a few days a dish of salad is produced by this odd miniature garden! And a little modification of this idea will enable the reader to follow us in our description of what next takes place. Let him construct the following simple contrivance:—procuring a piece of perforated zinc with fine holes, and cutting it into a triangular form, let each corner of the triangle be stuck into a flat piece of cork; place this in a tumbler of water, and it will float on its surface at the same time that the zinc is kept constantly half-covered with water. Now sprin-

kle upon the perforated plate a few mustard-seeds, and cover the whole with a small flower-pot. In about a day, or a day and a half, life has evidently begun, and its first stages may be watched, and will form a most interesting amusement. The accompanying figure contains a view of the whole of this simple apparatus.



Placed in the circumstances we have described, the seed begins to swell, and becomes sensibly softer than before: this arises from its imbibing moisture from surrounding objects, or, if half immersed in water, from that fluid itself. It swells more and more until its outer coats split open, and the tiny head of the young plant is seen peeping forth as a little yellowish white portion at one end of the seed. This increases in length and in size, and by-and-by a sharp glance will detect the appearance of another little portion, which also lengthens, and while the other invariably strikes upwards, the latter as invariably strikes in the opposite direction, or downwards. It is easy to guess now which portions of a plant

these two minute projections represent — the up-tending one is the future stem, and the descending one is the future root. The appearance of the seed with its two new appendages at this time may be thus represented. The terms used by botanists in speaking of the young stem and young root are, respectively, the *plumule* and the *radicle*. Every day adds strength to the young plant. Its radicle goes deeper into the nurturing earth, and its little plumule struggles up steadily and bravely through the dark over-head, as though impatient to respond to the call which the busy world above was making for its appearance. Looking now upon the earth's surface in the spot where a long while since we set the seed, we find it swelled and beginning to heave up and crack. If a little of it is gently removed, behold! the young plant is rising up, and in another day it has over-topped the soil. A pair of minute leaves become now visible; these extend themselves, spread out into the fresh air, and welcome the drops of rain, while the stem of the plant becomes stronger and stronger, and grows both thick and tall. The

GROWING SEED.

plant also, from being yellow or white, becomes of a most refreshing green.

Nor is the root idle. It pokes its unlighted way through the smallest crevices of the soil. It absorbs the water which flows down there, containing much food for plants in solution; and so soon as the leaves above begin to do their duties, to maintain the health and life of the plant, the root puts out a number of little roots, which strike off at right angles, and set out all in search of more food for the stem and leaves, which, since they are now growing very fast, they call for most imperiously. The roots thus extend in every direction, until they fill the earth below with a mass of the most delicate and beautifully white filaments, like fine threads. By this time the plant has risen several inches above the earth, and is daily putting forth fresh leaves, and increasing both in elegance and in stature and diameter. It now also fulfils all the functions of a perfect plant.

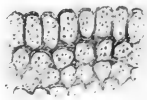
How has all this train of beautiful events taken place? There are two answers to this question, one of which we shall call the anatomical, and the other the chemical. Both are of the

highest interest; let us, therefore, glance at the first before speaking more in detail upon the second.

Has the reader followed our recommendation, and watched the growth of the mustard-seed? and has the question never arisen in his mind, how does this plant grow? how does it become larger and larger, and thus put out shoots which, respectively, seek the light, and bury themselves in the soil? Surely these questions deserve an answer, if one can be given. The question can be to some extent satisfactorily answered, for the microscope has shed its light upon the subject. By its means, then, we have ascertained the following facts; the merit of many of which is chiefly due to the celebrated botanist Dr. Schleiden.

By means of a very sharp razor we are able to cut off a thin morsel from the seed; and, on looking at this with a good microscope, we find it all made up of cells, looking like so much delicate and beautiful lace-work. Now, these little cells are every one of them little *bladders*, made of vegetable tissue for their sides, and containing inside a number of grains of starch

and other substances, as may be seen by the accompanying figure. These cells possess some singular properties. They are able to produce other cells like themselves, and these may produce others again, and so on infinitely. What now would follow from this fact? Suppose a single cell produced five more, and each of these five, and so on, yet that all stuck together into one mass, the result would be that the mass would increase in size,—in other words, it would *grow*.



PLANT-CELLS (*Magnified*).

This is just what takes place in the seed when *it* grows. The little cells we see figured above, become the parents of a great many more of the same kind. This takes place chiefly at that part of the seed where the little *plumule* and *radicle* are found: thus we see that, by more and more cells being born, the *plumule grows*, and the same with the *radicle*. Hence we might, for the sake of clearness, liken the growth of the stem of a plant to the building of a chimney: by adding brick after brick, it becomes taller and taller; and if, while we added bricks to the top, we also added a brick or two now and then to the sides,

it would become thicker and thicker. So it is in the plant from the beginning to the end of its existence. It is always growing tall and stout, by fresh cells of different kinds being added to it, at the top for the stem, at the bottom for the root, and at the sides for the branches. Thus we may say that a whole tree is a mass of little vegetable cells, put together in different ways, and of different kinds as to what they contain inside, &c. Methinks I hear one say,—What! is wood made up of cells? are leaves, and flowers, and fruit, all cells! All are cells,— but containing various different ingredients, and shaped in various different ways, as they have different and perhaps opposite duties to fulfil in the great tree to which they belong.

Yet more wonderful is the fact, that all these minute cells are so many chemical laboratories, in which the most remarkable changes take place. Here, for example, in these little cells is prepared the food which is to nourish and sustain the lives of men, beasts, and birds. Here, also, all our pleasant odours are produced, before the evening air, laden with dew, has snatched them from the flower; strong and potent drugs to

relieve human suffering, or to heal bodily diseases, are also made here. Colours bright as the rainbow, and more pure in their tint than any that human art can compose, are likewise formed and locked up here, whence they are often extracted by man, to apply them to his own purposes. They are, in fact, both the receptacles and also the producers of every vegetable product, however varied in its character, or strange in its properties. As we proceed in our history of the life of a tree, this fact should never be lost sight of,—that all the changes and decompositions of which we shall have to speak, take place in these little cells, each of which, although independent of the others, because there is no opening from one into another, yet acts in beautiful harmony with the rest.

We have now to ask the reader's attention to the answer which Chemistry gives when *she* is asked, How does the seed come to life, and grow into a great tree? First we may ask, What are the components of the seed itself? When the infinite variety of seeds is remembered, and when we consider to what millions of different plants they give rise, many of which are as op-

posite to each other as can be conceived possible, is it not somewhat astonishing that in four words we can tell the composition of them all? Without exception, then, all seeds are made up of four different substances: Carbon, Hydrogen, Oxygen, and Nitrogen,—the latter in minute quantities. These substances do not exist separately, but are combined together, some of them uniting to form what we call starch; some to form the vegetable tissue which enters into the husk of the seed, and some to form what is called gluten. Thus starch, vegetable tissue, and gluten are the three components of all seeds, and they are made up of four simple elements, which we have just named. A little experiment will prove the presence of these ingredients in a seed. If the reader will procure a little of the flour out of which brown bread is made, he will find it full of little scales of *bran*, which are of a light brown colour. By throwing it on a fine sieve, the bran may be separated, and the flour falls through. This bran is the outer husk of the seed, and is composed of *vegetable tissue*,—thus one of the ingredients of a seed has been found out. Now, by mixing the sifted flour with a little water, it

becomes what, in the language of the kitchen, is called *dough*. Taking this and working it between the fingers under a little stream of water for some time, at length we obtain a sticky substance like bird-lime,—this is *gluten*. And if we collected the water after washing the lump of dough in it, we should find it quite milky, and that soon a white powder would settle at the bottom,—this powder is *starch*.* This simple and easy experiment or analysis, then, tells us in unmistakable language what enters into the composition of a seed, so far as its first constituents are concerned; but it would require the most profound knowledge of chemistry, and the most delicate and costly apparatus to find out what these three ingredients were made of. This has, however, been done, and the result is given in the four words abovementioned.

Here then is the preliminary chemistry of a seed; let us now see what happens when we put it in such a position as that it shall be supplied with moisture, air, and warmth. If we go to a

* The starch sold in the shops is procured by a process similar to this, principally from potatoes.

maltster's, and get permission to look at the grain he is making into malt, in its different states, we shall enjoy an excellent opportunity of seeing how the process goes on. Here it will be seen that large masses of barley, which have previously been moistened with water, are strewed upon a brick-floor. The room is entirely dark, for, strange to say, seeds will not begin to grow in the light! as if they were sensible that they were not in their proper place when exposed to the glare of day; and, by means of holes cut in the walls and door, air is admitted in sufficient quantity. The ordinary warmth of the air is sufficient for the purpose of causing the seed to grow.

Seeds placed in this condition, if still alive, cannot fail shortly to manifest the fact by beginning to swell and soften, and put forth the young plants. This process is called *germination.* It is, in fact, the awakening of the powers of life in the seed, and their developement into the production of a new and beautiful being—the infant plant. On examining the barley, 1st. it will be found that it has absorbed or drunk in all the moisture which was thrown upon it. On putting the hand into the midst of the grains,

they will be found, 2nd. to be quite *warm*, although no heat has been applied to them. And if one or two are tasted, they now possess, 3rd. a very agreeable sugary taste. This is all that the maltster requires in order to prepare the grains for becoming malt; and as he knows that, if he permitted the process of germination to go any further, the young plant would in its growth consume all this sugar, he determines now to kill the seed; and lighting a fire below the floor, he heats it until the barley is dried and killed. It is then *malt*, and is fit for brewing into ale or porter.

Now there is a great deal of chemistry in all this; and we hope to make it easily intelligible to an attentive and *careful* reader. Water is taken into the seed,—this is the first fact. It serves to dissolve and soften some portion of the ingredients of the seed, and so prepare it to undergo a change of nature; for it is an important rule in chemistry, that any substance when dissolved is more easily decomposed, or made into another substance, than if solid. But simultaneously, or nearly so, with the absorption of water, the seed also absorbs a portion

of oxygen gas from the air.* This, of course, we cannot perceive by our senses; but it is a well known fact, and is the source of the warmth felt. In so doing, a most singular thing takes place,—*the starch becomes converted into sugar*, and thus, as sugar is easily dissolved in water, while starch scarcely dissolves in *cold* water at all, the young plant receives its first nourishment in a liquid form. Thus we see that the sweet taste of malt is accounted for.

We said that the sticky substance remaining after washing "dough" in water is *gluten*. It may now be asked, What becomes of this ingredient of the seed when the latter begins to germinate? This question has puzzled some of the most eminent chemists; and although we believe we now know what takes place more perfectly than formerly, yet we must not deny that it is still very obscure. It seems to be converted into a new substance, so that, instead of remaining insoluble in water, it is now quite soluble, and therefore is just in that condition

* The composition of the air is as follows. Nitrogen and oxygen, with small but vastly important traces of carbonic acid gas and ammonia.

in which it ought to be for the wants of the plant; for both the gluten and the starch are the stores of food which are providentially deposited in the seed, and which nourish the young plant until it is able to obtain food for itself. Both these remarkable changes of insoluble into soluble substances, so beautifully contrived to meet the necessities of the infant plant, are begun by absorbing water from the soil, and oxygen gas from the air. Therefore, if we attempted to make a seed grow without giving it water and air, we should certainly not succeed.

Some remarkable experiments upon growing seeds have been made with several interesting results. Seeds have been placed in the receiver of an air-pump, and by pumping out all the air a vacuum has been obtained; but, although moisture and warmth were supplied to the seeds, they refused to shew the least inclination to germinate. They have also been put into glass-vessels, full of some other gas than pure atmospheric air, such as the gas which is in soda and other effervescent waters — carbonic acid; and the gas with which balloons used to be filled on account of its lightness—hydrogen. The

end of these experiments shewed two things: 1. That seeds will not germinate if deprived of air;—and 2. That the air in which they germinate *best* is that of the atmosphere: that is to say, that man cannot by his skill make any artificial air or gas which will answer the purpose so well as that which the Creator has made. The knowledge of the first of these facts explains to us how it is that seeds will not grow if buried too deep in the earth. How many a young florist has been disappointed, after weeks of patient watching, weeding, and watering, to find his stocks, or his sweet-peas, or his mignonette, shewing no symptoms of "coming up"! Had he known this simple fact, he would never have dug a hole more than half a foot deep, and dropped his seeds in, ramming down the heavy earth upon their heads. Hence we find all gardening-books tell us,—many of them perhaps without knowing the reason why, excepting from experience,—when we sow our seed, to cover it very lightly with earth. Hence also the farmer takes care that the furrows shall not be too deep on the surface of his field, when the corn is about to be committed to its nursing-

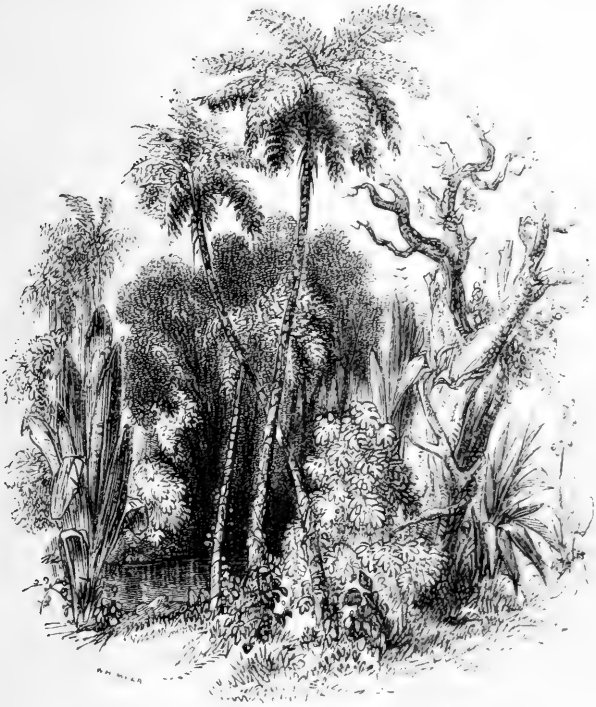
mother the earth. This will also explain the appearance of a number of plants on a lump of earth which has been brought up to the surface from a depth of several feet. The seeds were long since imbedded in the lump, but could not struggle into life because of the depth at which they were buried, and the consequent exclusion of air. Finally, this will also lead us to understand the best mode of conveying seeds from place to place. For example, it has been found that the only way to bring many seeds from distant regions to our own country, is to pack them in boxes full of clay rammed hard in. In this manner the seeds of the Mango, from the West Indies, and those of the beautiful Araucaria Pines from Chile, have been successfully brought home to England.

A large number of plants, however, produce no true seed, nor are produced by true seeds themselves. These belong to that division of the vegetable kingdom which contains the flowerless plants.

Any one who has noticed the slimy, green covering, which frequently paints our stuccoed walls, with a dark and dirty hue, has seen plants,

minute though they are, but plants which never sprang from seed. Any one, too, who has picked up the straying sea-weed, torn by the wave from its deep home of rock, however varied its appearance, has found another instance of a flowerless and seedless plant. Wandering also among the grave-stones of some old church-yard, and picking out of the deep-graven letters some tiny and hair-like mosses, we shall fall upon a third variety of these plants. And upon the giant arms of many a veteran oak, which in our forests has braved the "battle and the breeze" for centuries, behold a fourth kind comes under our notice, in the dry and shining lichens which give it such a venerable aspect. Down in the deep shade of the woods, where the summer brook bathes the feet of the thickly-clustered trees, springs another kind, the *fungi;* some, it is true, not very attractive in colour, but others painted in such delicate flushes of pink and white, as might grace many a fair lady's cheek. The edible mushroom belongs to the same class. The next family of plants, the *ferns,* however, will supply us with the best and most elegant illustrations of this peculiarity.

We know nothing of the grandeur of ferns in our own country. Few among those who pick up their strange stems by the way-side, would



TREE FERNS.

imagine that, in warmer regions, they even become trees. To look at the accompanying figure, we should at first suppose these tall and elegantly

crowned trees to belong to the royal family of the Palms, but they are true ferns;—strange to say, they produce no seed, and are therefore placed by the botanist in a position very little above Club-mosses, and the ditch-loving Horse-tails. To the inquiry, How then do new plants spring forth? we must answer by turning up the leaf of the fern, and there, without the help of a glass, we shall perceive little cases or cells, which contain within them a multitude of very minute bodies, called in botanical language *spores*. These are really very small cells, organised in a peculiar manner, which, when placed in favourable circumstances, begin to form new cells, and ultimately become the perfect plant. They are so light as to float frequently in the air, and are thus conveyed to great distances, where, mayhap, they are dropped, and in time grow up and become strong plants. In all the kinds of plants abovementioned, this method of reproduction is observed; only it varies in the beautiful contrivances by which the tiny spores are dispersed abroad. In the case of the sea-weed they are carefully wrapped up in what seems to be a piece of jelly, and are carried by the currents of

the great ocean from shore to shore, until they stick to some favouring rock, where they begin to grow, and in time bring forth their irregular stems, and leaves, if we may call them such. The remarkable plant beforementioned, the "Red-snow," as it is called, is produced also by little cells of this kind.

This little plant, being of a blood-red colour, has often been the innocent cause of much popular alarm. We frequently read, for instance, in old books, of the occurrence of showers of blood, and noted as demonstrating the special anger of God against a people or district; and, in truth, the blood-bedropped ground presented a spectacle sufficiently calculated to arouse the easily excited fears of an ignorant age. Modern science in this, as in many other instances, has destroyed these unreasonable apprehensions; and informs us, as has been before mentioned, that the light *spores* of the red-snow plant, wafted through the air, and dropped on the surface of the earth, are the cause of the marks, so long looked upon with dismay.

We cannot tell how the early processes of life take place in these classes of plants: they

have not been watched with the care bestowed upon the germination of the seed. We may certainly conclude thus much concerning them,—they are of far greater simplicity than the corresponding phenomena in the seed. A certain amount of moisture, and an appropriate degree of temperature, must undoubtedly be necessary to their developement; beyond this, the chemistry of the young life of the plants produced from spores is buried in darkness. In the mature age of some of them, as we shall presently have to see, they exhibit a most remarkable phenomenon of a chemical order, and prove themselves the complete exceptions to the rest of the vegetable world.

The curiosity attending the production of plants in yet another mode, justifies its being shortly mentioned before we conclude this chapter. We were lately permitted to examine a magnificent conservatory full of tropical plants; among which were some of the most elegant and graceful of the Fern family. On looking closely at the leaves of these plants, the most curious phenomenon presented itself: at their edges were a number of *young ferns*, all vigor-

ously flourishing, and in all the different stages of their growth. The botanical expression for this strange method of reproduction is, that the plants are *Viviparous;* that is, that they bring forth their young not in the state of seed, but as young plants: which is a very different thing from what was mentioned of the mangrove. In that case, the seeds were first produced and ripened, and grew on the tree, instead of in the soil: in this, the young plant never was a seed; or at least, if perhaps in the fern we might suppose that the *spore* ripened as in the mangrove, many other instances exist where no such thing as a seed or a spore preceded the birth of the plant.

The following is a very remarkable and beautiful experiment. If a leaf of the plant called *Bryophyllum Calycinum*, a relative of the house-leek family, is placed upon a little bed of moist soil and carefully watched, it will not fade and die as most leaves do in a similar position, but will continue fresh and green, and manifestly alive and well; by-and-by its edges begin to swell, and in a little time, to the amazement of the beholder, he finds a number of minute

young plants putting out their tiny leaves in this singular position, and becoming strong and large. If, again, we break a portion of a leaf of the Gesneria, it puts out, says Dr. Schleiden, a new young plant in about a week: the same takes place in several other plants. Sometimes, indeed, the leaf itself will grow when planted and set in the soil favourable to it. Orange-trees have been grown in this way; and it is well known that, in the middle ages, a travelling florist, named Mirandola, went about teaching "the art of making trees out of leaves." It may be added also, that the little organs we call "buds" occasionally grow, and become perfect plants even in nature.

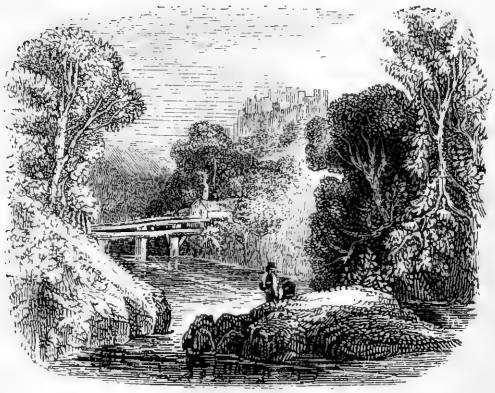
In these cases nothing worthy of remark exists, as to the chemical nature of the vital processes of the young plants, to justify their being considered separately from the notice we purpose bestowing upon this subject in the next chapter.

Such then is the infancy of vegetation:—passed in various regions and under circumstances as extreme to one another as the frozen north, and torrid zone. Climate makes no differ-

ence in the unvarying chain of processes which characterize it. The seed calls for heat, moisture, and air, all the world over, before it can live to become a plant.* This is one of those grand simplicities of Creating Wisdom, which fill us far more with wonder and admiration than the most complicated and ingenious effort of human skill. Had the task been given to man to accomplish, what an infinity of altering circumstances and forces would he not have thought necessary, to effect the germination of different seeds placed in the most opposite conditions! In the hands of the Creator of the worlds around and above us, see how a few and simple principles do all, and do all well—so that, while ages roll on, no part of the world once clothed with plants, shall ever again become deprived of its lovely raiment. This, indeed, is the characteristic of the works of God as opposed to those of His creatures,—that, while they must heap together a multitude

* Mr. R. Hunt has discovered that the rays of light which produce the effects known under the name of *actinism* are also necessary to the first germination of the seed, in addition to the three requisites mentioned in the text.

of means to accomplish a single end, He effects a multitude of ends by a single means: and any one who is familiar with the various kingdoms of creation, will be able to call to mind a large number of interesting examples, where this beautiful truth is beautifully worked out.



THE YOUNG TREE.

CHAPTER II.

THE YOUTH OF THE TREE.

The morning of vegetable existence possesses peculiar beauties, in common, indeed, with the early dawn of life wherever it is found. Of many created things, however, a young plant is the most beautiful object we can select. The tender stalk just rearing itself into the elastic air, bending with every whisper of the wind, and glittering with such a freshness of lustrous green, that it almost looks as if the hand of Nature had been varnishing it over anew with every morning's light,—presents us with a work of Creation so fresh and fair that it cannot be equalled all through the world. The young leaves are tinted with that peculiarly delicate green, which makes Spring the sweetest season of the year. They possess, too, such a downy and delightful softness

of texture, as to make it a pleasure even to touch these new-born organs. And the young branches seem so full of sap, as if they would burst their half-transparent coat. Then, too, every process of life appears in such vigour! The plant seems to drink in with joy the fresh-fallen shower; and grows at such a rate as almost to become visibly taller while we watch it. Strong in the vigour of its youth, and beautiful as strong, it has not yet felt the hardening influence of the world into which it has entered. Hours of genial sunshine gently pass over its head, morning and evening showers drop softly on its tender structures, and the moist earth fills its hungry roots with hourly food. It has never yet encountered the fury of the tempest, nor felt the heavy sweepings of the thunder-shower, nor the paralysing influence of the clear, cold, frosty nights. Before it is called upon to undergo these trials of vegetable life, it will have been hardened, and strengthened, so that "as its day, so shall its strength be."

When we take up a young plant which has just emerged from the bosom of the soil, and place it in contrast with a full-grown tree of the

same species, that which most strikes us in the comparison is the tender and fragile tissue of the one, and the firm, solid, and resisting structure of the other. The cause of this difference will easily be guessed; it is the formation and consolidation of wood in the latter; the young plant, on its first emergence, consisting chiefly of a delicate unresisting tissue, called by botanists the *cellular tissue*. Were the plant to remain in such a condition, that is, wholly made up of cellular tissue, it could never become a tree. The delicate cells are so feeble, and possess so small an amount of the force of cohesion, or sticking together, that even granting that the plant grew up into a tree, and put out branches, the first smart breeze would break off its head, and lay the fragile trunk prostrate on the earth. But God, who does "all things well," could never have permitted such a flaw in creation; and He has therefore appointed means of the most beautiful and faultless kind, by which it is so contrived that in ordinary cases, so soon as ever a plant comes into the broad daylight, immediately woody tissue begins to be formed. Long, though fine bands, of this firm tissue pass from

the leaves down to the roots, and *brace up* the plant, so that, even when it is a few weeks old, it is able to endure the angry buffetings of a very tempestuous wind.

We must now proceed to take up again the thread of our history. Having watched the plant from the seed to the seedling, we have now the pleasant task of tracing out the characteristics of its growth. If we place the date of its birth in the Spring, the advancing year brings fresh strength and grace to the plant. During the warm days of Spring and early Summer, the number of its leaves, and its strength, stature, and diameter, all increase. On cutting across its stem at this early period, it would be found to be divisible only into two parts: a central portion, or pith, of cellular tissue; and an outer layer or skin. But as the leaves multiply, and the whole size of the plant becomes enlarged, the stem is greatly altered too. The woody bands, descending from the leaves to the root, run between the bark or skin, and the pith, and consequently form a layer all around the pith, separating it from the bark: this layer much resembles a ring, and is called a *concentric ring*, or zone. Thus

three portions can be perceived in the stem,—the bark, the ring of wood, and the pith.

As the year goes on, the whole plant still increases in size, until Autumn, with its "sere and yellow leaf," comes apace. The leaves now formed are converted into various coverings for the little buds, which are to be found studding over the branches in various places. The old leaves fall from the plant, withered and dead, having fulfilled their allotted part. The buds become coated with a waterproof resin, which defends them from rain, whilst they are guarded from frost by several layers of leaves admirably folded over these tender points. These preparations tell us that Winter is coming, and strikingly illustrate the forethought characterizing all the works of Creation. By-and-by, Winter, wrapped in his white raiment, comes, and showers down on the head of the young tree a load of snow, while his cold breath covers the branches with a varnish of ice. But the plant has nothing to fear for itself, or for its tenderest organs,—all are safe; and thus, in that very scene which we so generally consider the most forcible representation of desolation, the snow-covered forest, a very

little knowledge of Botany enables us to see, in these simple but effective protections, marks of a Creator's wisdom, traces of a Father's love. Are there no snow-storm epochs of the human life, in which the instructed eye may not, if it will look for them, see the same, causing the heart to acknowledge that in the darkest hours He is nigh, and that, be the trial never so sharp, it is not without its alleviations!

The long days of Winter move gradually on; now cold and sharp with frost, now dark and lowering with snow, and occasionally wet and chilling with half-frozen rain. The plant is, as it were, asleep. To look at its stiff and naked branches, one would say it was altogether dead; and if we were to thrust a sharp weapon into its trunk, not even a drop of fluid would escape from the wound. It is waiting for the Spring, and while it waits it sleeps; and so ends the first year of the Life of a Tree.

But as the Earth rolls on her endless path, gradually a warmer air wraps her round in this our hemisphere. The ice-chain begins to be loosed, though now and then a sharp frosty night will close the cold links again. The great Sun

rises higher and higher in his daily circuit, and his life-giving rays communicate warmth and vigour to all creation. Animals shake off their winter's sleep, and come abroad out of their lairs. Birds re-appear as if by magic,—for we scarcely know where they all go to during the dark Winter season,—and while they seek out their mates, fill the fresh air with music. The surface of the river moves again, and begins to be broken into rings by the dancing flies and leaping fish. Does the tree remain asleep while all creation is awaking? Far from it.

The young buds cast off their thick Winter coats, knowing that Summer is nigh at hand; and as we watch the topmost of them, we may see them turgid with juice, and ready to burst into all the luxuriance of Spring. As they increase in size they unfold themselves, and in a little while we altogether lose the form of the bud in the elegantly veined and now fully expanded leaves. The same process takes place on every branch; bud after bud disappears, to give place to the beautiful young leaves; and Spring, as it advances, finds that the once barren and apparently withered object, that looked as if insensible

to its encouraging voice when it was first heard, has now become an elegant young tree, adorned on every branch with the finest raiment, and of the most pleasing colours.

It is easy to stand by, and watch these processes as they gradually develope themselves; and a mere child can trace them from first to last, as far as they are visible to the eye. But the greatest philosopher cannot answer the inquiry, —Why do they take place? or explain how it is that the returning Spring re-awakens the slumbering tree. This is because we are ignorant of what vegetable life really is. And though chemistry can tell us much about its different phenomena, and though the microscope may actually shew us what takes place, we are still as much in the dark as ever as to the power which sets them all in motion. Let not the reader suppose it is merely the returning warmth of air, and the re-softening of the frozen soil, that are alone necessary to recall the plant to life. There is something more than this in the case; and what this is, is yet hidden from our view. If a plant were a mere machine, or if indeed it were simply a beautiful form of chemical apparatus, it

would all be cleared up by reference to the well-known laws of mechanics or chemistry. But the plant is a living being; and that at once explains our difficulty, while it leaves us in our darkness.

It must not, however, be supposed that we cannot give any account of what takes place: this we shall endeavour to give as shortly as possible in the clear and concise language of one of our most eminent Botanists.* "The buds gradually unfold, and pump up sap from the stock remaining in store about them; the place of the sap so removed is instantly supplied by that which is next it; an impulse is thus given to the fluids from the summit to the roots; fresh extension and fresh fibrils are given to the roots; new sap is absorbed from the earth, and sent upwards through the wood of last year, and the phenomenon called the flow of the sap is fully completed, to continue with greater or less velocity till the return of the Winter.

"The growing point lengthens upwards, forming leaves and buds in the same way as the parent shoot; as horizontal increase of the whole of the

* Dr. Lindley. *Introduction to Botany.*

cellular system (or pith) of the stem takes place, and each bud sends down ligneous matter within the bark and above the wood of the shoot from which it sprang; thus forming on the one hand a new layer of wood, and on the other a fresh deposit of bark."

We thus see, that the following distinct phenomena may be recognised in this portion of the history of a tree: the expansion and functions of its leaves, the flow of its juices, and the formation of cellular and woody tissue. It will be convenient to speak of the flow of the vegetable juices, previously to our mentioning some particulars respecting the other phenomena.

If in an early summer-day a notch is made with a knife into the stem of a healthy succulent plant, immediately it is seen to bleed, pouring forth a clear, somewhat viscid fluid. If now the notch is made deeper and wider, we can see from which portion of the stem the fluid runs; and a little examination will shew us that it is from the stem below, and not from that above the cut that it chiefly proceeds. We learn from this, that the motion of the sap, for that is the proper name of the fluid, is very strongly in the direction from below

upwards; for the cut surface next the ground streams with the exuding drops: but if we look at the upper surface of the cut, we shall find it not to be quite dry, but that here and there tiny drops of crystalline fluid are seen to flow from countless minute tubes. This teaches us a second fact about the circulation of the sap, informing us that there is also a motion from above down again toward the earth. If, again, we could water the plant with some coloured liquid which it would absorb, and were then to cut it quite across, we should see that veins of colour ran to and from the pith, indicating that the cellular tissue (that is, the pith, and the horizontal rays which we see radiating from it,) is also penetrated by the sap. Thus, then, the sap moves from the roots to the branches, from the branches to the roots, and from the outside to the heart of the stem.

Another little experiment will shew us through what parts of the stem the two different currents of sap move. If we only cut into the bark, a very small portion of fluid exudes from the inner part of the cut; and this comes from *above*. We have already seen that the course of the sap in the *wood*

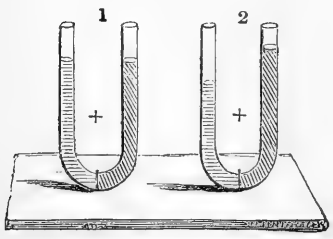
is from *below;* and we thus gather the important fact, that sap *rises* through the wood, and descends between the wood and the bark, and through the inner portions of the bark also. Beginning from the roots, we may trace its circulation through the tree in the following manner. A heavy shower of rain falls, and fills the soil with moisture: as it filters downward it dissolves many ingredients which it meets with in the earth, and coming at length into contact with the delicate roots, it is drunk in by them, and so enters the system of the plant. Immediately it begins to move upwards; passing along the roots it enters the stem, ascends through the woody tissue, enters the leaves, is there exposed to the light and air, thence descends again through the bark, and reaching the roots is discharged, having fulfilled all the duties required of it, to give place to the continually in-pouring stream which goes through the same career.

The force with which this circulation takes place is very surprising. By taking a young growing branch of a tree, and fitting one end of it into a glass tube, and by means of a little cement making the joint perfectly tight, we shall

be able to measure this force. A little water must be poured into the tube; and taking care that it does not run out, by placing the finger on the open end, it must then be plunged into a basin containing a little quicksilver. The accompanying cut will represent the method of arranging this apparatus. In a quarter of an hour the heavy quicksilver will be seen to have risen up into the tube, and will rise until it actually touches the end of the branch. The great Dr. Hales made some most beautiful experiments on this subject, and found a branch of a nonpareil apple-tree, with twenty apples on it, actually sucked up a column of mercury a foot high in *seven minutes*. The result of his experiments shewed that, in some instances, the power which moves the sap in plants is five times stronger than that which drives the blood through the artery in the horse's leg.

APPARATUS FOR SHEWING THE FORCE OF CIRCULATION.

There appear to be two principal causes of this singular phenomenon—the circulation of the sap. One of them is, that the plant loses, by perspiring through its leaves, an immense quantity of fluid, which it can only obtain by sucking it up from the cells next to it; and these becoming empty, suck fluid from those below them; and so on, all through the stem, down to the very roots. The other is the singular phenomenon called *Endosmose*. Suppose on one side of the tube shewn in the figure, we poured a measured quantity of water, and on the other side an equal quantity of milk, and separated the two fluids by stretching a thin piece of bladder across the tube, just in the bend at +. At first thought we should say that they would remain without mixing together. But the contrary is the case; although there is an imperforate piece of animal membrane to separate them, yet, strangely enough, the water goes through and mixes with the milk, while little or no milk comes through



ENDOSMOSE-TUBES.

to the water; so that, after a little time, the tube containing the milk is fuller than that containing the water, as is represented in the figure 2. This in-rushing tendency of a thin fluid when only separated from a thicker, such as milk, by a delicate membrane, is called Endosmose. It is supposed in the case of plants, that the greater thickness or viscidity of the sap acts like the milk in the tube, and attracts the thinner water from the earth surrounding the roots, into the roots themselves, and thus a sort of motion becomes established. Undoubtedly the first is the most powerful cause of the two.

The sap of plants is often highly valuable to man. In North America an immense amount of sugar is obtained almost exclusively from the sap of the Maple: by boring a hole a proper distance into the trunk, and fitting a wooden tube to it, the free end of which dips into a suitable vessel, a large daily supply of sweet juice is obtained, which, on undergoing the boiling and purifying processes of the manufacture, yields a very pure and pleasant sugar. Several members of the royal Palm tribe also furnish a highly valuable sap. In the fair Island of Ceylon

palms are planted in regular order, for the express purpose of tapping for their sap. These plantations go by the name of *toddy topes*, the exuded sap being called *toddy*. We are told that some of these trees, in the hot season, will yield the enormous quantity of one hundred pints of sap in twenty-four hours. The sugar in this sap soon causes it to ferment, and thus supplies the natives with an excellent wine; and by distillation a very burning sort of spirit called *arrack* is formed. The strange Cactus tribe, with its leathery coat of tissue so admirably adapted for the dry and parched positions in which it is found, frequently supplies the thirsty wanderer with a spring of water in a dry and weary land, where no water is for miles to be found. By stripping off the outer coat of formidable prickles, an abundance of pleasantly-flavoured watery sap is found within; nor can it be doubted that by this peculiar provision, which has been called "The Spring of the Desert," the life of the exhausted traveller has frequently been preserved. Dr. Schleiden tells us also that "the wild ass of the Llanos knows well how to avail himself of these plants. In the dry season, when all animals flee from the glow-

ing Pampas, when Cayman and Boa sink into a death-like sleep in the dried up mud, the wild ass alone, traversing the steppe, knows how to guard against thirst: cautiously stripping off the dangerous spines of the Melocactus with his hoof, and then in safety sucking the cooling vegetable juice."

Some races of plants, however, possess a large amount of vegetable juice which widely differs from sap, properly so called, in both its appearance and properties. In the common lettuce and in the dandelion, we have good specimens of this peculiar fluid or milk. Every one knows what happens when we break off the head of a dandelion-flower,—how an abundance of milk-white juice comes pouring up from the stalk, which possesses a very peculiar smell, and leaves a sticky feeling on the fingers. We shall call this the milk-sap of plants. It is not, like ordinary sap, common to all plants, but is peculiar to two or three families.

When we come to examine into the nature of this fluid, we find in it a most startling resemblance to the blood of animals, or perhaps more closely to their milk. It is well known that either blood or milk, when drawn from the body and allowed to stand, presently separates into two

parts,—a clot or cream, and a thin fluid or whey. Singularly enough, this milk-sap has the same property; when it is drawn from the plants in which it flows, it separates, just as they do, into a cream or clot, and a thin fluid or whey. Nor can we mix them together again when they are once separated in this manner. It is found that the milk-sap when fresh drawn, before its separation, consists of a vast number of small globules floating in a clear fluid, and thus giving it a milky appearance. On standing, the little globules collect together, and float at the top like cream. It is also very remarkable that this fluid is not, like common sap, found in all the tissues of the plant, but exclusively in a beautiful mesh-work of fine tubes, which exist principally in the bark of the milk-bearing plants. On this account the discoverer* of them was led to consider that the milk-sap was really a sort of vegetable blood, and that these tubes were the veins in which it flowed. But it does not yet appear that this opinion is correct.

Although confined to a few vegetable tribes, the milk-sap is almost of more value and importance to mankind than the sap proper. When

* Prof. Schultz of Berlin.

we enumerate caoutchouc, or India-rubber, opium, and many terrible poisons such as the Woorari, Upas, Strychnia, among its products,—that will be sufficiently manifest. Caoutchouc is derived solely from the milk-sap of plants: it is this singular substance which forms the cream observed in the separation of the milk into its two portions. The supply is derived from several different trees and regions of the world; and is obtained by cutting deep incisions into the bark, and conducting the thick and precious juice out, by wooden troughs, into a proper receptacle.

The most fearful poisons known are found in this juice. The savage Indian well knows this fact, and dips his unerring arrows into the deadly fluid of the Mandioc, or into the deadlier compound familiar to us under the title of the Woorari poison. In the thick ancient forests of Java, where the step of man seldom enters, and where the voice of the bird and the shriek of the active monkey fill the air all day long with sounds of life, grow some of the most swift-slaying plants in the whole world. Even to touch the juice of one of them will produce rapid and dangerous blisters. The extracted juice of the other, when

applied to an arrow-tip, will instantly make the stoutest brute inhabitant of the forest tremble when pierced therewith; and in a few seconds fall to the earth in brief, rapidly fatal, death-spasms.

Yet, as if to counterbalance these poisonous attributes, the milk-sap of some plants is perfectly harmless. In the Canary Islands we are informed that a milky juice is obtained from a tree, which closely resembles sweet milk, and, thickened into a jelly, is eaten as a luxury by the natives. But the Baron Humboldt has related one of the most interesting facts connected with this subject. "On the barren flanks of a rock grows a tree with dry and leathery leaves; its large woody roots can scarcely penetrate into the stony soil. For several months in the year not a single shower moistens its foliage. Its branches appear dead and dried; yet, as soon as its trunk is pierced, there flows from it a sweet and nourishing milk. It is at sunrise that this vegetable fountain is most abundant. The natives are then seen hastening from all quarters furnished with large bowls to receive the milk, which grows yellow, and thickens at the surface. Some drain their bowls under the tree, while others carry home the juice

to their children; and you might fancy you saw the family of a cowherd gathering around him, and receiving from him the produce of his kine. We drank a considerable quantity of it in the evening before going to bed, and very early in the morning, without experiencing the slightest injurious effect." The name of this remarkable tree is the *Palo de Vaca*, or *Cow Tree*, it is a relative of the humble nettle which grows by our way-sides. A similar tree, called *Hya Hya*, flourishes in the dense forests of British Guiana, and produces a milk of an agreeable flavour in such abundance, that some travellers, having once felled one of a large size that stood near a brook, found that, in the course of an hour, it coloured the water quite white and milky. It is time, however, that we now retrace our steps, and proceed to the leaves of the plant.

Taking the course of the ascending sap as our guide, we are conducted into one of the most beautiful and important studies of the whole vegetable history. The clear stream of fluid penetrates swiftly along the minute woody tubes, which form the outer portions of the stem, carrying dissolved in it many soluble chemical salts, obtained

from the earth, and some soluble secretions which it finds in the cells of the stem. Taking thus the character of a liquid food, it rises higher and higher, enters the leaf-stalk, and then sheds itself into the thousand cells of the leaf. The structure of the leaf is admirably adapted to effect the alteration and conversion of sap into nutriment for the plant. It consists of an upper and under delicate layer of outer cells, which are very close together, so that but little fluid can escape from them, — this is called the *epidermis*, or skin; and between these two layers is a thicker one of cells, through which bundles of woody tissue run, forming the veins of the leaf. On the under surface are a number of minute mouths, which form the guardian-entrances to little air-cells within the leaf, and are called *stomates*. These little mouths open and close, according to the varying necessities of the leaf, sometimes being open to allow moisture to escape, at others, opening to admit the moisture of the dewy night, and being closed afterwards.

Thus it is manifest, that there is the most complete provision in this organ—the leaf—for exposing to the influence of the air and light, the

juices poured from the stem into its countless cells; and we shall find that both light and air exercise a wonderful effect upon it, and upon the whole system of the plant. If we were asked What is the leaf to a plant? it would be perhaps hard to give a better answer than—Both its stomach and its lung,—that is, both the organ for digesting food, and the organ for breathing air. Dr. Lindley writes: "It is not improbable that the cells of a leaf which form the upper stratum (or layer), perform a function analogous to that of the stomach in animals, digesting the crude matter they receive from the stem; and that the lower stratum takes up the matter so altered, and submits it to the action of the atmosphere, which must enter the leaf purely by means of the stomates." Thus the upper layer is the *stomach*, and the under layer the *lung* of the plant. When we consider the usual position of leaves, one surface always looking to the sky, and the other toward the ground, we can readily imagine that this is the case; and that light acts principally upon the upper surface, while air acts chiefly on the under. In the Australian woods there is a singular exception to

this rule as to the position of the leaf-surfaces. There trees are to be found which scarcely cast a shadow, their leaves being twisted as it were half round, and turning one *edge* to the sky, and the other to the earth. Such trees form the most singular features of the landscape.

Let us now ask the reader's attention to another interesting topic. Down in a deep cellar, whither no ray of light has ever entered except that of the dimly burning candle, lies a neglected heap of onions. The moist earth on which they are placed quickens several of them into life, and they begin to put forth their sprouts. Doomed to an unbroken darkness, and wrapped round by fostering damps which rise from the floor, the shoots still grow, and become lengthened considerably, straggling about the place as if groping for the light. The pleasant days of Spring pass quickly on, bringing life and health to all the vegetable creation above ground, while these poor prisoners stretch out their pallid shoots hither and thither, and weary themselves in their struggles for the broad daylight—all in vain. At length they wither and die, and soon become covered with mould, and crumbled to dust. Why is this? Why were the

wandering shoots of a pale yellow? And why did they wither away and die, leaving the empty flaccid outer membrane of the onion, as the only testimony to their ever having existed? It was not because there was no soil into which the fibrils of the roots might not have struck and found food. Neither was it for want of air, or warmth, or moisture. The following anecdote will prove that something beside all these was necessary. A potato lay in a dark place underground, where a few rays of light would occasionally steal in by a hole in the side. In due time it began to shew signs of life, and in a short while a tender sprout sprang from it. This sprout, like that of the blinded onions, wandered about striving to escape from its dark den, until at length it got within the influence of the pencil of light-rays streaming in through the hole. Strange to say, it groped about no longer, but made directly for the hole, and before long actually pushed itself through, and appeared in the glad light of day above; here it grew, and became a healthy plant. On carefully looking at its stem, it was found, that all that portion of it which remained in the underground cavity, was almost white; but all

the rest, which was sprouting out its leaves in the free air, was of a dark, and refreshing green colour.

It was the *absence* of *light*, then, that proved fatal to the unfortunate onions. Under the influence of light the *green colour* of plants is produced, and not without. The market-gardeners are well aware of this fact; and, in order to prepare for the table such vegetables as celery and asparagus, they carefully exclude the light by means of large earthen jars or pots, or by heaping up earth upon the young growing plants. The stalks thus become turgid with juice, but remain of a yellow colour, veined, in the case of celery, with red lines. Mr. Ellis states in the "Gardener's Magazine," that in North America the operation of light in colouring the leaves of plants, is sometimes exhibited on a grand scale, and in a striking manner. Over the vast forests of that country clouds sometimes spread and continue many days, so as almost entirely to intercept the rays of the sun. In one instance, just about the period of Spring, the sun had not shone for twenty days, during which time the leaves of the trees had reached nearly their full size, but were of a pale whitish colour. One forenoon the sun broke through in

full brightness, and the colour of the leaves changed so fast, that by the middle of the same afternoon the whole forest, for many miles in extent, exhibited its usual Summer's dress. Nor is this the only result of exposure to the influence of light. As we shall presently have to see, the formation of the wood of plants is proceeded with under the influence of the light of day alone. All the complicated phenomena of digestion, and of the various chemical processes which take place in plants, are equally the results of the wonderful influence of the solar ray. Without light, no odoriferous flowers could adorn our earth; nor could any of the valuable and useful medicinal resins which we find in plants, be produced. Sometimes, indeed, human art avails itself of this fact; and when we wish to procure a vegetable full of sweet or limpid juice, and free from its natural acrid, or even poisonous properties, we cause it to grow in such a manner, as that light can scarcely exert the least influence on the portions we consume. Thus for instance—One among other reasons for tying up the tops of lettuces, so as to bleach all the heart-leaves, is to exclude the light, and thus obtain a mass of leaves free from

the narcotic properties which we find present in the outer green leaves which are exposed to all the glare of day. The bleaching of celery, above noticed, has the same end in view; for the celery plant belongs to a highly poisonous family of plants, and possesses many acrid qualities itself, which would totally unfit it for the use of the table if grown unbleached.

Such, then, being the effect of the absence of light, we should naturally expect that in those bright regions, where sunlight throws its golden floods in greatest profusion, where the clear air is seldom filled with murky clouds to dim their rays, and where the rich Earth displays, as elsewhere we find not, her primeval fertility,—here plants must possess, beyond those of other regions, the odoriferous and resinous products which light contributes so largely to produce. And this is so. Who has not heard of the spicy breezes of the warm Ceylon? Where lie the lands —the homes of the clove and cinnamon? Where shoots the strong shaft of the Camphor-tree? Why is it that in Persia poets have sung sweetest, of the sweet subduing odours of the rose—queen of flowers? Why that in the glorious South Ame-

rican forests every air wafts its burden of the rich and varied perfume of the orchid-flower? Because here the light-gates of heaven are widest open; and here the genial, ever active and all-powerful solar rays, quicken into existence products unknown save by report to less favoured regions.

A very curious effect of light of a different kind has been noticed in a plant which is a native of India, named the *Bryophyllum Calycinum*. The juice of this plant is said, on good authority, to be quite acid in the morning, to be tasteless in the middle of the day, and, more singular still, to be bitter at night. This plant is not peculiar. Liebig, the eminent German chemist, cites another example in the *Cacalia ficoides*. The probable explanation of this strange alternation of properties is, that during the night the plant absorbs oxygen gas, during the light of the morning it loses it again, and at eventide, having lost still more, it acquires a positively bitter taste.

Let us turn aside for a moment to speak of a series of most singular experiments, which have been instituted by several philosophers, and particularly by Mr. R. Hunt, on the influence of different kinds of light upon plants. Six boxes

were so prepared, that air was freely admitted to the plants within them, without permitting the passage of any light except that which passed through the coloured glasses with which they were covered. These glasses were of the following colours: a *ruby*, a *brown-red*, an *orange*, a *yellow*, a *cobalt-blue*, and a *deep-green*. The young plant first broke the soil in the box covered with orange-glass, and last under those covered by yellow, green and blue glasses. It was subsequently found that the effect of the yellow rays was such as to prevent the germination of the seed, even although the rays only rested on the surface of the soil, while the seed lay buried beneath; and, again, that the blue light seemed remarkably to favour this process. Under the *orange* light the plants grew very tall, but had *white* stalks, and refused to put forth any flowers. Under the *yellow* light, it was remarkable that a number of little fungi, or moulds sprang up and flourished luxuriantly, while the plants themselves withered and died. Under the *red* light the plants only grew an inch or two high, had something of a reddish colour, and soon rotted and perished, although supplied with abundance

of food in the soil in which they were placed. Under the *green* light the plants grew slowly, but tolerably strong; yet none would flower, notwithstanding the greatest care and attention were bestowed upon them. The results under the *blue* glass were very different. The roots germinated a little less quickly than in the open air; but the plants became compact and healthy in their character, putting forth their flower-buds strongly, and flowering in perfection. Under this light alone did the various processes go on with that vigour which is characteristic of vegetation in the open air.

A very striking circumstance occurred in the experiments with the red light. It has been already seen that plants turn eagerly toward the light; and this fact may often be witnessed in our sitting-rooms where a plant is placed in a window, for in a few weeks it is seen to have bent itself, as if in grateful homage, to the light of day pouring in at the window. Very opposite to this was the behaviour of plants, upon whose tender structures the fierce red rays were alone allowed to fall. As if sensible of their deleterious influence, the plants actually *turned away*

from the over-powering glare; and this took place in every experiment conducted on the subject, —thus evidently shewing that the red light contained some principle, to the presence of which vegetation shews the greatest aversion.

These considerations lead us to another and more remarkable feature of the vegetable life. We have said above, that when a plant first pierces the soil, and clambering through the yielding particles of brown earth lifts up its tender stem to the gaze of day, it consists almost exclusively of cellular tissue, and is therefore as fragile as possible. To become useful in the world of Nature, and for the purposes of man, it must undergo an important change of nature; in other words, it must become wood.

Now it is a beautiful truth, that no sooner does the plant see the light than this indurating or hardening process actually commences; shewing us that all things have been so harmoniously ordered, that no sooner do circumstances call for an alteration in the constitution of the plant, than a fresh chain of events is set in motion to effect this very end. Down below the earth the firm woody tissue was unnecessary; for there no

tempestuous winds can operate to threaten the uptearing of the tender thing. But when its young leaves emerge, and bathe their fresh structures in sunlight, dew, and air, then the period of danger comes; for the clear sky may soon blacken with clouds, and the still air be tossed into a hurricane—and then, what of the probable fate of the fragile plant, had not an All-wise forethought given it inward strength before! And he that knows what is the pressure of some storms of life, when darkness and despair seem as if they would overwhelm the man on whom their fury falls, may often mark with wonder the firm endurance the afflicted one displays, little considering that the fair season before was the time when he was strengthened to withstand the storm. Thus, to the plant, the first gleam of daylight is a messenger of health and strength, for with the falling of the first ray of light upon its leaves commences the formation of those down-penetrating woody bands, which communicate resistance and endurance to its youthful frame.

Where does the wood come from? If we were to take up a handful of soil and examine it under the microscope, we should probably find it to con-

tain a number of fragments of wood, small broken pieces of the branches or leaves, or other parts of the tree. If we could examine it chemically, we should find yet more strikingly that it was nearly the same as wood in its composition. Perhaps then, it may be said, the young plant obtains its wood from the earth in which it grows? The following experiments will shew whether this conjecture is likely to be correct or not.

Two hundred pounds of earth were dried in an oven, and afterwards put into a large earthen vessel: the earth was then moistened with rain-water, and, a willow-tree weighing five pounds was planted therein. During the space of five years, the earth was carefully watered with rain-water or pure water. The willow grew and flourished; and, to prevent the earth from being mixed with fresh earth, or dirt being blown upon it by the winds, it was covered with a metal plate, full of very minute holes, which would exclude everything but air from getting access to the earth below it. After growing in the earth for five years, the tree was removed, and on being weighed was found to have gained one hundred and sixty-four pounds, as it now weigh-

ed one hundred and sixty-nine pounds. And this estimate did not include the weight of the leaves or dead branches which in five years fell from the tree. Now came the application of the test. Was all this obtained from the earth? It had not sensibly diminished; but, in order to make the experiment conclusive, it was again dried in an oven and put in the balance. Astonishing was the result—the earth only weighed *two ounces* less than it did when the willow was first planted in it! Yet the tree which grew in it had gained one hundred and sixty-four pounds.

Manifestly, then, the wood thus gained in this space of time was *not* obtained from the earth. We are, therefore, compelled to repeat our question—Where does the wood come from? We are left with only two alternatives,—the water with which it was refreshed, or the air in which it lived. It can be clearly shewn that it was not due to the water: we are, consequently, unable to resist the perplexing and wonderful conclusion,—it is derived from the *air*.

Can it be? Were those great ocean-spaces of wood, which are as old as Man's introduction into Eden, and wave in their vast but solitary

luxuriance over the fertile hills and plains of South America—were these all obtained from the thin air? Were the particles which unite to form our battle-ships, Old England's walls of wood, ever borne the world about, not only on wings of air, but actually as air themselves? Was the firm table on which I write, the chair on which I rest, the solid floor on which I tread, and much of the house in which I dwell, once in a form which I could not as much as lay my finger in, or grasp in my hand? Wonderful truth! All this was air.

In a note at the foot of a former page, we mentioned the composition of the air in general terms. We may here re-state it a little more precisely thus. After a careful analysis by some of the most eminent chemists of the nineteenth century, the true composition of the air we breathe is the following,—supposing that one hundred cubic feet were taken:—

Oxygen gas	$20\frac{3}{4}$
Nitrogen gas	$79\frac{1}{8}$
Carbonic Acid gas, Carburetted Hydrogen gas	$\frac{1}{8}$
Watery Vapour—*variable.*	
Vapour of Ammonia—*traces.*	
	100.

Carbonic-acid gas is the important ingredient as far as our present subject is concerned. This gas is contained in all effervescing liquids, is produced by burning wood or coal, or gas in the air; and also by the breathing of man, animals, and birds. It is a very heavy gas, much heavier than air—so that, in fact, it can be poured from one jar into another. It is moreover a highly poisonous, deadly gas, and if breathed for a little time by any human being, it would rapidly destroy his life. Yet, as we have said, every living being, at every moment of his existence, throws from his lungs this same gas.

The composition of wood when analysed by the chemists is very simple: it may be said, to speak roughly, to be composed of one half of carbon and one half of the constituents of water, or hydrogen and oxygen gases. The composition of carbonic-acid gas is one part of carbon, and two of oxygen gas; so that, to produce wood, we only require to take away the two parts of oxygen gas, and to add to it the constituents of water. But the highest art of the chemist cannot effect this. He can unmake wood, and accurately tell us what are its components; but to unite its dissevered parts so

as to produce a firm and solid substance like wood again, he is altogether powerless. A blade of grass, or the youngest and tenderest leaf of the forest, is immeasurably his superior in this as in all its other proper chemical processes.

Now we are prepared to approach this beautiful page of vegetable history in the right manner. We have been shewn that the source of wood lies not in the soil, nor in the heaven-falling rain, but in the wide expanse of our enveloping atmosphere. And that the minute portion of carbonic-acid gas in the air is the ingredient from which it is derived. The question now presents itself—How is this singular decomposition effected? Knowing the source of wood, shew us the manner in which it is obtained.—This we shall proceed to do.

EXPERIMENT WITH A SPRIG OF MINT.

Suppose we pour a little carbonic-acid gas into a glass jar, at the bottom of which is a little saucer full of water, and then drop a sprig of growing

mint into it, and stopping it up close expose it to the sunshine for a certain time. May we expect any change in the air contained in the jar? Whether we expect it or not, a great change will certainly take place. After the lapse of a few days we shall find that, whereas the air of the jar previously would have instantly extinguished a burning taper, now the taper actually burns more brightly in the jar than in the open air. And if we were sufficiently expert in practical chemistry, we should detect the very curious fact, that all the carbonic-acid gas had disappeared, that in its place was an equal amount of oxygen gas; and, in addition, that the plant had increased in weight. We are thus plainly taught that plants can decompose the carbonic acid of air, and give back its two parts of oxygen gas, keeping its carbon, which they turn into solid wood, and thus increase in weight.

This sprig of herb is a type of what takes place on the large scale all through the vegetable creation: the mightiest monarch of the ancient woods can do no more, and owes all its majesty of form and gigantic proportions

of structure to this simple fact. Thus then the truth appears, that the vegetable world obtain all their strength, solidity, and size, from the decomposition of a gaseous ingredient in the viewless air.

This function is principally confined to the leaves. Owing to some mysterious and peculiar power, the leaves are always drinking in carbonic-acid gas from the air. After its inhalation they have the power of condensing and decomposing it; and the result is, that they pour back all its oxygen gas, and retain all its carbon, out of which they then proceed to elaborate woody tissue. But this process of decomposition does not go on but under certain restrictions. For example, soon "as the evening shades prevail," from the grass blade to the rustling raiment of the forest, all leave off work and cease to decompose carbonic-acid gas for the night. The red streak in the distant horizon, left by the down-sinking sun, tells the busy vegetable crowd its daily labour 's done, and bids it fold its leaves to rest for the night. Obedient to the signal, the flowers fold up their painted petals, and droop the neck in the full attitude of rest. The leaves

of many plants fall and lie against the stem, reposing from their labours. Night comes on. The pale moon climbs the dark star-sprinkled firmament, and sheds her soft radiance over a slumbering world. The hours steal by: man and beast are still at rest, and vegetation shares the general repose. But in the far East see the first grey streak, the foretoken of the rosy-fingered morning. Then comes the cold and misty morning twilight; and in a little while the great Orb of day himself rises in glorious golden majesty above the horizon. All things awake now to active duty; and the great world of plants is busy again on its daily task of forming, out of gas, the firm structures of branch and stem and root.

Plants, however, do not wait for the full blaze of morning sun to renew their toils. So soon as ever a dim general light is thrown across the earth—so soon do they begin their work; although, of course, they perform it most actively in full daylight.

This periodical resting of plants at night, is a very interesting fact. It shews us that the presence of the light of day is necessary to

assist them in fulfilling their vastly important office—the decomposition of carbonic-acid gas; and that when this is withdrawn, then this office ceases until the return of morning. De Candolle, the French botanist, tried to make plants decompose this gas, by exposing them to the rays of powerful lamps; but he could never succeed in causing them to do so. Hence it follows that sunlight is the agent which quickens this process into existence, and which, indeed, sustains it in activity when commenced. And if we come to ask what principle it is which exists in the light of the sun to cause it to effect these changes, we can only answer, that it appears to be the *chemical* or *actinic rays*, which are chiefly concerned in effecting it.

At night, when these chemical rays no longer fall upon plants, as has been said before, the process stops. For a long time some talented philosophers actually thought that at night a precisely opposite decomposition took place: that is, that plants emitted carbonic-acid, and absorbed or drank in oxygen gas, instead of absorbing as they do in the day carbonic-acid,

and pouring forth oxygen gas. And it is very certain they do pour out a *little* carbonic-acid gas at night, but it is very small in quantity, and seems to arise simply by evaporating from the leaves, since the sap of plants always contains a little of this gas dissolved in it.

Wherever plants are best exposed to sunlight, as a general rule, there they are the strongest and healthiest. Every one who lives in a great smoky city, and takes pleasure in trying to rear a few plants on his narrow window-sill, must have wondered and at the same time lamented over their pale and sickly look, as compared with the deep green hues of the country plants of the same species. The reason is simply this, that the thick state of the air, and the tall houses around, so diminish the force of the light, that the poor plants only receive a tithe of that received by those which luxuriate on some sunny bank, looking to the warm south, in the country. On this account, trees which grow alone, and are therefore exposed on all sides to the light, are well known to form more tough and durable timber, than such as grow in thick forests where

light reaches only their topmost boughs. The brittle Wainscot Oak of the Black Forest is produced by the same species as that which produces the tough and solid naval timber of Great Britain: but while the one is produced in half-obscurity, the other stands often alone, enjoying the fresh light and air of our broad fields.

If this is true, it may be said,—Then plants would grow best of all if exposed to perpetual sunlight. But this would not be the case. It appears probable that no created being can do without a certain amount of repose, and plants among the rest. Their nightly cessation from toil is as necessary to their health as their daily amount of labour also is. Hence where, as at the Poles, a continual shining of the sun exists for a certain space of time in the year, vegetation does not thrive under it as it does in the regions where regular successions of day and night occur; and not a tree is to be found in all those dreary kingdoms of frost.

From the hundred thousand chimneys of the great metropolis, every winter's day, there proceed

some millions of cubic feet of the gas, whose connexion with the world of plants has detained us for the last few pages — carbonic-acid. One healthy adult man, in the course of a day of twenty-four hours, pours from his lungs about fifteen thousand cubic inches of the same gas, containing, upon calculation, about six ounces of solid carbon. So that, if we consider London to contain two millions of inhabitants, this number of human beings every twenty-four hours casts up, in the form of gas from their lungs, the astonishing amount of upwards of *three hundred and thirty tons* of carbon. If we could reduce this to a solid form, and suppose the products of London respiration for one day stored up as charcoal, or coke, and now grant that a family uses twenty tons of fuel in a year, then the breathing of the population of London for twenty-four hours would furnish one such family with household fuel for sixteen years and a half, and would demand a coal-cellar as great as two or three houses put together.

These facts are mentioned, not to excite an unreflective curiosity, but to impress upon the

mind the enormous mass of impurity daily thrown into the atmosphere from one locality alone, and to stimulate the reader to follow us with interest as we proceed to inform him how, by a wise and admirable regulation, it is all removed from the air again; if indeed he has not already anticipated the solution to the difficulty. Let us bear in mind then, that all men, all animals and birds, and all combustion of fuel, are engaged in filling the air with carbonic-acid gas, which has been already said to be produced in breathing, and from burning coal and other fuel. The tendency of all this is to fill the air with poison,—for carbonic acid is poisonous,—and consequently to render it quite unfit for us to live in. And there is not the least doubt that in time this would actually take place, and the wide world would not own either a man, beast, bird or insect, all having perished by inhaling the deadly atmosphere.

Now comes the beautiful discovery of the office of the vegetable world to our relief; for we find here a law at work which exactly neutralizes all the poison, and restores its lost purity to the atmosphere again. He who or-

dained the animal functions so as to throw out this poison, also ordained the vegetable powers to drink it in,—and more, even to live upon it. Plants inhale the gas as fast as it is produced from the opposite sources: out of it they form their solid wood, turning the poison we might almost say into gold, certainly into a material of all others most necessary and valuable to mankind.

Thus a beautiful connexion is established between plants, animals, and men. The vegetable kingdom can no more dispense with this gas in the air, than the animal with the oxygen gas, which air also contains; nor can either say to the other, "We have no need of you." The fact is, vegetables live upon what animals would die from, and thus consuming the deleterious ingredient, not only secure their own health, but also that of the animate creation at the same time. It seems that the great Creator of all things never intended any part of His creation to stand alone. Man himself is quite dependent upon the beast of the field, and the tree of the forest; and all through creation we may see the same law prevail. Thus, little as the thought

may generally impress us, there is not a leaf among the countless millions of the forest, nor a blade among the green army of the meadow-grass, which is not of importance to mankind and to the brute creation.

Nothing grows in vain. The least flower has a part of the great work of purification of the air, that falls to it; for although it might not be missed out of the innumerable ranks which adorn the garden or the wayside, we must not forget that the whole universe is made up of a combination of little things, and though the importance of a tiny plant may be little in itself, it forms one of a number, which however vast is, after all, only made up of individuals, each having a share in the task to be done. We might go even lower in the scale, and say, each little cell of the green duckweed floating in our quiet pools has its share of work; for it is an interesting discovery, that even these little masses of vegetation exercise a purifying influence upon the boundless air.

Yet we must not forget to mention, that a most remarkable class of exceptions to this rule is known to Botanists. These are the curious

plants, of which we have before made casual mention, the *Fungi*, or Mushroom tribe. Strange it is, that these plants, instead of loving the pure daylight, and eagerly pressing up into its presence, both hate it and fly from it; and equally strange, that instead of helping to purify the air, they only help to pollute and poison it. Mr. Hunt, in his researches on light, found out a very curious thing about these plants. It is well known that the country people say the mushroom loves to grow in the light of the moon; and Lord Bacon tells us "that they come up hastily, as in a night." Now it is very probable this proverb is founded in fact, and that the mushroom tribe, if it loves any light at all, prefers that of the pale, cold, silent moon "that walketh in brightness." Mr. Hunt found accordingly, that mushrooms would grow luxuriantly under a yellow light, which approaches nearest to the colour of the moonbeams. Perhaps some of our readers may not know, that in the large underground excavations, called catacombs, under the City of Paris, there are regular nurseries for *fungi*, kept by some of the poor inhabitants to supply the tables of the rich with these delicacies. Here

they grow without one ray of light ever visiting them, and thrive most luxuriantly. It is necessary to take a candle to attend to these funny plants; and a few months ago a poor mushroom-grower nearly lost his life by his candle going out, and leaving him in the dismal caves in impenetrable darkness. Fortunately, after three days his friends found him out, and rescued him from his terrible tomb. Near Dresden there are some extensive coal-mines which are celebrated for their fungi; for here they thrive luxuriantly, and, what is more striking, they possess luminous properties, so that they light up the black galleries hewn in the coal, in some places with such brilliance, and such a beautifully soft irradiance, that the mine has all the appearance of an enchanted palace.

These plants, as we have said, absorb oxygen gas from the air, and exhale carbonic-acid,—the exact reversal of what takes place in the rest of plants. Indeed, in this respect, they actually resemble animals. This has been proved by some interesting experiments performed on the subject by M. Marcet. We might therefore imagine that fungous plants were actually prejudicial to

the welfare of the animal world; and, so far as they exhale this gas, they are. But they have been well called the "scavengers of nature;" for they live by consuming up what would otherwise perhaps produce a poison. Hence we find them upon decaying fruit, bread, &c.; and they very soon remove all the offensive matter, converting it into vegetable mould—after which no further danger of its decay is to be apprehended.

But to return. The fair days of Summer have gently glided over the head of the young plant. The evenings draw in, the harvest is past, the field again yields to the bright plough-share, and puts on her brown dress once more, and Autumn, heavy-laden with fruits, appears before us in all her soberness and mellowness of aspect. But what change is this which has come over the plant's leaves? Whose pencil has turned their fresh hues of green into brown, yellow and red? And see! the last brush of the wind has scattered a heap of them at our feet. This is the change and fall of the leaf!

It is a very difficult thing to understand the precise nature of the changes which undoubtedly

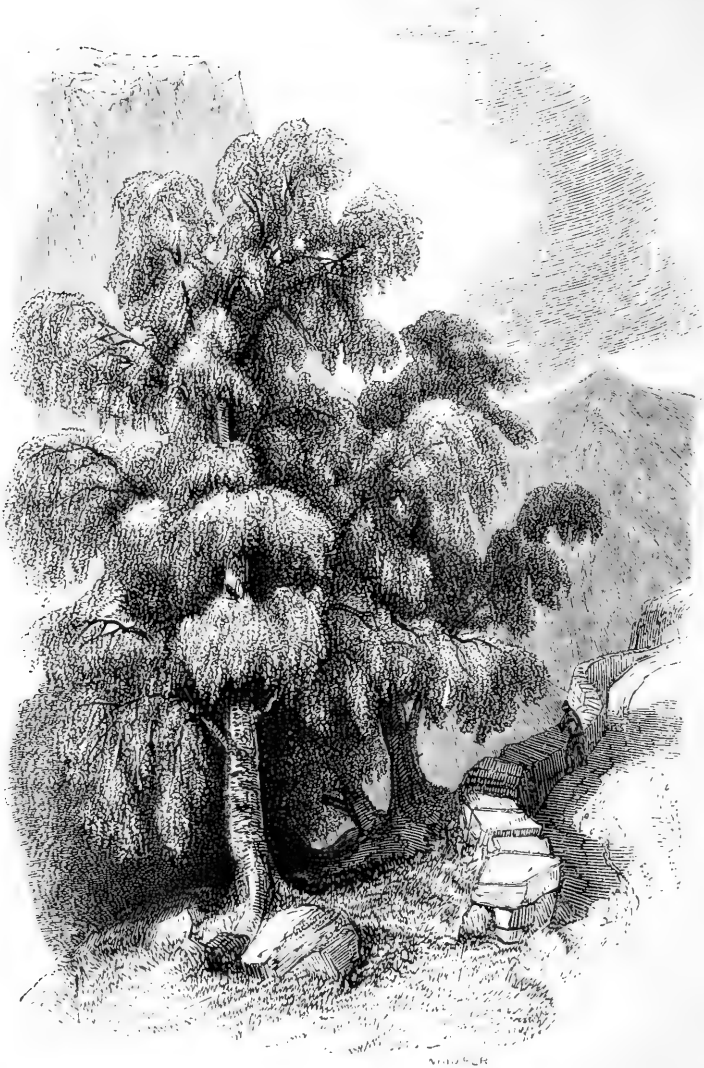
accompany the mere change of colour in the autumnal-tinted leaves. Mr. Hunt, whose name we have before mentioned, is inclined to believe, that the chemical influence of the sun's rays is modified or altered at this period of the year. The change in colour of the leaves is, perhaps, due to their absorbing oxygen gas, which they will do in the dark and in other circumstances. For example, if we expose *dried green leaves* to the action of oxygen gas in a glass jar, and moisten them with a little water, they rapidly change colour and assume something of the Autumn tint. Hence we may suppose, that the exciting power of the chemical rays of the sun, being less in Autumn than in Spring and Summer, renders the leaves less able to resist the action of this gas; and the consequence is, that even while on the tree they feel its effects nearly as much as if they were already dead and dried,—and thus the change of colour is produced. This, however, may perhaps be too abstruse a subject for the general reader, and we must pass on to ask:—

Why does the leaf fall? A great number of talented men have endeavoured to give different

explanations of this subject also; but we must confess it is anything but clear even now. One eminent French Botanist tells us, it is because certain delicate little tubes become suddenly broken at the stalk of the leaf, so cutting off the communication between the leaf and the branch; and then, of course, it dies and falls off. Another tells us, that the poor leaf dies of overwork: it evaporates so much water, that the solid impurities left behind fill and choke up all its pores, so that by the Autumn it can do no more work of this kind, and therefore dies and drops off. Dr. Lindley seems to think, that it is due to both these causes combined.

Though ignorant of the cause of these changes, we may derive instruction from their solemn tones of warning! "We all do fade as doth a leaf!" Just as after a few swift months of Summer, the declining year tinges even the freshest forest leaf with its under-tones of colour, — sure token of advancing decay and death,—so the grave lineaments of age come upon the freshest and fairest countenance, and carry the same lesson with them: the day of life is nearly spent, the night is

at hand. Happy are they who, like the forest leaves, well and faithfully fulfil the duties God has appointed to them, and, like them, only "rest from their labours" when their allotted work is done.



THE ADULT TREE.

CHAPTER III.

THE ADULT TREE.

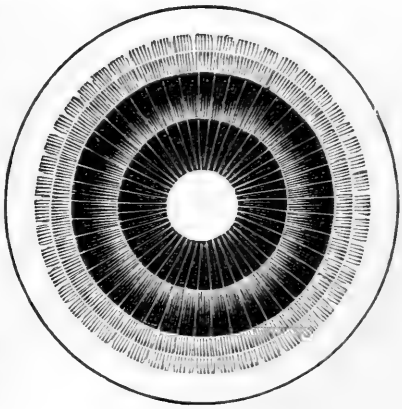
When a writer on fiction, taking up his tale, as we have done, from the birth of the hero or heroine, as the case may be, has exhausted all he has to tell about the infancy and childhood of these personages, he is very often obliged to have recourse to a little artifice in order to get over the years between youth and manhood; and he generally tells us at the beginning of perhaps his third chapter, that we must be so kind as to suppose that a certain number of years have slipped by between the close of the second and commencement of the third chapters of his book. We see no more convenient way of getting out of the same difficulty; and we must therefore beg the reader to be equally indulgent to our history, which has the advan-

tage of being all true, and to imagine that ten or twelve years have elapsed in the life of a tree since we last took it up.

In the place then where, twelve years ago, a pippin or an acorn fell, we now behold a strong and vigorous tree. What a change is this! The little seed, buried in insignificance and weakness, has been raised in power: the dangers which threatened its infant life,—the sharp tooth of frost, and the rough wind of heaven,—are now all at an end. No longer a tender, fragile, delicate being, at the mercy of the storm, or exposed to the peril of destruction by the careless tread of the roaming beast, it waves its comely branches on the summit of a tall and stout, but pliant stem. Gliding time has scarcely yet effaced the charm and grace of youth from the tree. Its bark still retains the smooth unwrinkled look of early years, and rich in juices, bleeds forth a stream of green sap if touched by the pruning knife. As years roll on, all these, the distinctive features of the tree just arrived at its perfect condition, will be removed; and, wrinkled with many a deep furrow, and made to look venerable with a coating of grey

mosses or lichens, which give it the look of old age, it will stand in the orchard or take its place in the forest in much the same sort of character as a gentleman of five-and-fifty stands in human society.

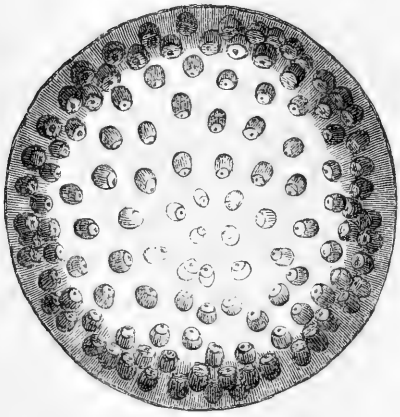
If we were now to take a saw and cut across the stem of the tree, we should find a very curious change to have taken place in the wood. A number of distinct circles, like those represented in the cut, are seen to surround the pith which is in the centre. And also a number of lines are observed running from the centre to the outermost ring. These circles are the rings of wood mentioned at page 41, and called *concentric rings*, or zones. The lines which give the piece of wood a star-like look are called *medullary rays*, and are supposed to be intended to connect the pith with the circumference of the



SECTION OF AN EXOGEN.

wood and intervening parts. The ring nearest the pith was formed in the first year of the life of the tree, and every succeeding year leaves its mark in the addition of a ring for each, composed of the wood formed during the year by means of the leaves.

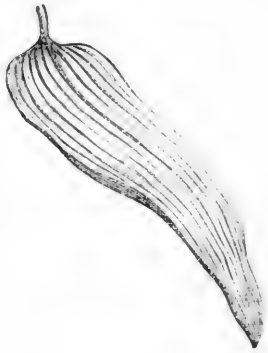
It is necessary however to say, that there is a large division of trees and plants in which these rings will not be found,—such, for instance, as the sugar-cane, the palm-trees, and many more. These trees are also different from such trees as apple and oak-trees, in that their leaves are marked with straight lines instead of like a net-work, as will be noticed if we examine an oak-leaf. These differences are also shewn in the cut. The trees marked with the rings are called *exogenous* or *dicotyledonous* trees; those merely



SECTION OF AN ENDOGEN.

marked irregularly with holes, *endogens* or *monocotyledons.*

LEAF OF AN EXOGEN.



LEAF OF AN ENDOGEN.

We have just said each of these rings stands for a year. As will therefore be quickly imagined, we have only to count up how many rings there are from the centre to the circumference, and we shall learn how many years have passed over the head of the tree, or, in other words, how old it is. And this is, in fact, a very sure guide; for the rings form a very correct register of the age of the tree. A singular use has been made of this fact, which deserves remembering. Many of our readers are probably aware that the coal which we burn for fuel was a very long time

since in the form of wood, and of living plants. Now sometimes persons have found in beds of coal pieces, which, though quite converted into coal, still exhibit the marks of the *rings* of which we have been speaking. These persons, knowing that each ring was the sign of a year in age, have counted them up, and have thus been able to tell how many years old the tree was before it was changed into coal. And not only so, but as the rings are wider or narrower apart, according as the seasons are fine and favourable for the formation of wood, or as they are cold and unfavourable to that process, they have been able to learn also, almost, we might say, what kind of weather it was at the particular period when these very trees were alive, which must have been at least many centuries ago! This gives us a good illustration of the delightful and interesting information, which even a moderate knowledge of any science will enable us to enjoy. Henceforward, when the reader passes a tree felled by the woodman, and lying by the wayside, let him spend a few minutes over it in counting up the rings, which he will readily detect at the cut end; and he may have

the pleasure of knowing, without much chance of being far wrong, the age of the fallen trunk.

So much for the changes that have taken place in this interval. The Winter's sleep is again shaken off, and the tree begins to resume the duties of life. In a little while, the forest, which a short time since stood out all bare and rigid against the clear, sharp winter sky, becomes gradually clothed with leaves, and soon in such abundance that the eye can no longer penetrate as before into its inmost recesses. The voice of Spring to creation—Awake, sleepers, and live! has been heard over hill and dale, and all Nature has responded to the call, adorning herself with robes of living green,—coming forth as it were to salute the beloved season.

Having in our last chapter glanced at the different duties of the leaves, let us now spend a short time over those of the roots, and answer a few questions upon the *Food of Plants.*

Some of our readers will perhaps say, Have we not already seen that plants feed on air, and obtain all their wood from the carbonic-acid gas mixed in the air,—what more do we require? True, but this is not all:—no! nor even, after

all, the most important food of plants. Some pages back, in our home analysis of a seed, we saw that it contained a sticky substance, which we could wash out of a piece of dough by means of water; this substance was termed *gluten*. It contains a large quantity of the element which chemists call nitrogen. Now where did this nitrogen come from? and how did the plant obtain it? The answer will come very quickly, perhaps, into some minds. Why, the air is composed of oxygen and nitrogen, therefore it was obtained from the nitrogen of air. This ingenious reply, however, will not avail us; for it has been positively ascertained that it does *not* come from the nitrogen composing the air.

Perhaps there may be a little difficulty in comprehending the exact nature of the correct answer; but we shall endeavour to render it as intelligible as possible. Beneath the spout in yonder farm-yard is a wooden butt, into which the rain, collected from the roof of the farm-house, is conveyed, and is there kept for different purposes. Let us remember, all the water this butt contains comes from the clouds,—and as it dropped through the air, naturally would dissolve

anything of a soluble kind existing in the air through which it fell. When this water has been allowed to stand a day or two, we then find it begins to smell rather disagreeably, and a good nose might detect a faint odour, something like that of smelling-salts, proceeding from it. This smell is partly due to the presence of a small quantity of a substance called *ammonia*, which is composed, as the chemists tell us, of two gases, —nitrogen and hydrogen. Now *ammonia* easily dissolves in rain; and as it could not of course have come from the roof of the farm-house, or from the water-butt, it must have been obtained from the air,—and the rain having fallen from the clouds, must have dissolved it, and thus brought it to the earth.

Now we are approaching the true answer. Since we are quite sure that the element nitrogen in plants was not got from the gas nitrogen composing the air, and since there is no other substance in the air but ammonia which is composed of nitrogen, it is only fair to conclude that this part of the food of plants, for such it is, was obtained from the *ammonia* floating in the air. And this is the true reply.

This may not be thought to be very important for us to consider; but what would the reader say if we were to cut off all his supply of milk, of cheese, and of fresh meat,—and how would he thrive without them? Each of these articles of our food is produced *actually from the ammonia of the air* in the following manner:—First, grass and other plants receive ammonia by means of rain as food for them, and make use of the nitrogen it contains for *their* purposes. Second, the cow and the sheep eat up the grass and other plants, and they make use of the nitrogen they find in this sort of food for *their* purposes; for example, to produce milk, and the ingredient which forms cheese contained in milk, and, finally, to nourish their flesh. Lastly, man consumes the milk, and the cheese, and indeed the animals which form them for *his* food; and the nitrogen they contained goes to strengthen and support his body. Therefore we might actually say, that we ourselves partly *live upon air;* for one of its ingredients, nitrogen, by means of these different channels, comes to us as the most important element for our nourishment. This is a beautiful link of chemical processes, and well deserves the reader's

thoughtful attention; nor is it, when thus presented to his mind, hard to understand, or to remember.

Rain itself is also a most important part of the food of the subject of our history—the Tree. The great traveller Baron Humboldt certainly tells us, that he has seen in some of the burning countries he has visited, certain trees which really seemed capable of living without rain; and for months of bright and hot weather, during which no rain fell, these singular trees preserved their freshness of look as though they were watered every evening. He could only account for it by supposing, that at night the leaves possessed the power of absorbing moisture from the air; and this is probably the real explanation of the phenomenon. Generally, however, rain or moisture from the soil is indispensable to the health of plants and trees. Mr. Darwin, in his interesting journal, gives us a lively picture of the blessings of rain in parts of Northern Chili. "That the surrounding country was most barren will readily be believed, when it is known that a shower of rain had not fallen for thirteen months. The inhabitants heard with the greatest envy of rain at

Coquimbo. I was at Copiapo at the time, and there the people, with equal envy, talked of the abundant rain in another spot. In ten days a single shower of rain covered a previous desert place with pasture: and it was very curious to notice that just so far as the shower extended this green pasture existed; all beyond was as barren as before."* Some calculations have been made as to the quantity of water consumed by plants, which are interesting. Thus a sunflower has been found to consume daily twenty-two ounces of water; and upon calculation, during one summer, an acre of land planted with sunflowers, at a moderate distance apart, would consume nearly two millions of pounds of water. An acre of cabbages would consume more than five millions of pounds in one summer, and an acre of hop-plants as much as six or seven millions of pounds.

The water is taken up chiefly by the roots of the tree, is then converted into sap, and as it is

* In another place Mr. Darwin speaks of the effects of a great drought. "During this time so little rain fell, that the vegetation even to the thistles failed, the nooks were dried up, and the whole country assumed the appearance of a dusty high road."

carried through the system of the tree it undergoes various changes to fit it for the different offices it has to fulfil. Wood, for instance, is not purely carbon, but consists of carbon and the elements of water, which were most probably obtained by the tree from the decomposition of the water taken up by the roots.

To pause for a moment here and to look back, asking ourselves What have we seen as to the food of plants? The answer is very simple: They live upon carbonic acid, and ammonia, and rain,—all derived from the air. Yet a little fireside experiment will suffice to convince us, that this is not the whole of the food of plants. A brightly burning log of wood lies blazing and crackling on the top of the fire. Burning away in showers of sparks, and casting up pale lambent flames, and now and then informing us that its cells contain water, which, being converted into steam and exploding, causes the cheerful crackling sounds we hear—the fire gradually dies down, we retire to rest, and repairing to the fire-place early in the following morning, we discover nothing left of the log but a heap of soft white ashes. Why has it not burnt away altogether, as, if the wood had

been purely carbon, hydrogen, nitrogen, and oxygen, it ought to have done, leaving nothing behind? The same experiment, if we can call so trifling an observation by so dignified a title, is made on the large scale in many a clearing, or spot redeemed from the forest in America. The settlers here are overwhelmed with the ocean of wood, which surrounds them, and effectually puts a stop to the pursuits of agriculture; and they have no resource but to cut down tree after tree and burn them. What a grievous waste! will be exclaimed by those who know the value of fire-wood, in our less densely wooded country. But not entirely so; the ashes are carefully collected, and are melted down, and are then found to contain very large quantities of the alkali called *potash*. This is then sent to market, and fetches a very fair price. We will mention another fact of a somewhat similar kind. In many parts of Wales a species of fern grows wild in great numbers, and beyond serving as litter for horses, or as thatching for the cottager's roof in the place of straw, might be looked upon as a very useless plant. The cottagers, however, estimate its value very differently, and collecting it together in heaps,

set fire to it, gather up the ashes and form them into balls, which they then send to the next market-town, where they find ready customers in the shopkeepers and laundresses of the place. These balls are used as substitutes for soap in washing; two or three being melted in water and added to that in which the linen is washed. These balls are, in fact, a collection of the alkaline and other ingredients formerly existing in, and being part of the food of the fern plants.

Thus, then, this interesting additional particular about the food of the tree comes out. It requires certain chemical substances, besides those which it derives from the thin and viewless air. In the cases we have just mentioned, it is evident that the alkali potash, which enters into the formation of our common soaps, was a part of the food of the trees and plants from which, when they were consumed, it was obtained—from the reason of its being itself incombustible. In addition to potash, the alkali soda and various other substances are now found to be actually necessary for the food of plants.

Many persons must have noticed the advertisements, in the different public papers, of different

kinds of manures to promote the growth of plants. How do these act? It is possible that many who employ, and some who even manufacture them, do not clearly know. But it is hoped the reader of this little book could, at this stage of our proceedings, give something like a correct answer. They promote the growth of plants because they supply to them these very substances about which we have just been speaking—the alkaline and other saline and mineral food of plants.* In ordinary circumstances, plants obtain this part of their food from the earth; the rain, as it soaks into the mould, dissolving out various salts, which are then drunk in by the tender rootlets of the tree—and so form part of its food.

The great chemist Baron Liebig, who first explained this very remarkable fact about plants, proposes a very ingenious and useful application of it. He says we have only got to burn a plant, and then get a chemist to analyse or find out the different substances contained in its ashes; and we thus have a sure guide as to what sort of manure we ought to give it, supposing we wish it to become very fruitful and supply *us* with a

* Some manures, such as Guano, supply plants with ammonia also.

large quantity of food. And he has even taken out a patent, which he has sold to Messrs. Muspratt of Liverpool, for the manufacture of an artificial manure adapted to supply every kind of plant with the saline and mineral food it requires. Thus it is probable that the science of chemistry will, in course of time, most materially increase the fertility of our fields and meadows, and help to supply the poorest of the land with cheap and sufficient food. Soon may this time arrive!

It will be easily understood that in nature,—say in the wild wood,—or on the open moor, plants will grow best where they can find most abundantly this food which they require; and as the nature of the food required for different plants varies, it is also plain, that whenever plants find just that peculiar sort of food in the soil which they require, *there* they will grow most abundantly. This, in part explains to us what otherwise seems a great mystery, as will be evident from the following particulars, in which it will be noticed that each plant has, as it were, its own district or home.

There is a pretty and peculiar little plant called, from the singularity of its flowers, the *man-orchis*,

growing in some southern districts of England, which is invariably found upon a soil containing lime or chalk. Another of them, the bee-orchis, is often found in chalk-pits. In Switzerland a very beautiful plant of this species is found growing upon the Alps. Whenever the soil contains limestone in this country, there the plant may be generally found. But as we travel on and enter in a region, which, though outwardly similar to the last, is found to contain a soil in which no limestone exists, there we cease to see the beautiful "lady's-slipper"—the name of the plant,—until, continuing our travels, we come again to a limestone district, where we behold its striking flowers once more adorning the way-side. Again, Have none of our readers in their sea-shore wanderings, fallen in with a peculiar class of plants which they will look for in vain in any other position? Why is this? Undoubtedly, answers the chemistry of vegetation, because the salt matters contained in the sea-shore sand are necessary as a part of the food of these plants:—that this is really so we are able to illustrate by a little circumstance, which came under our own notice.

Having occasion to make some researches in

the salt districts of Cheshire, the most appropriate spot for so doing was considered to be the neighbourhood of Northwich. We descended into one of the mines, and explored the vast beds of rock-salt, which are here hollowed out into glittering caverns, resembling enchanted palaces. Afterwards we repaired to some immense salt-works where the brine is pumped up from the earth and then boiled down; and here large reservoirs are placed for containing the brine. Conduits, or wooden pipes, run from one to another of these reservoirs; and as they are not made very water-tight, a number of little streams of the salt-water run out and fill the surrounding soil with salt. The bad and refuse salt is also thrown upon the surface; and, in fact, the whole district around abounds with saline matters, perhaps even in greater abundance than on the seashore. Now, to shew that it is not a mere accident which confines particular plants to the seashore, but that they really live there because they find there the salt food they like best: all along the way-side in this district these very plants were found, which are generally the dwellers near the sea. It is easy to guess the reason.

The soil contained a quantity of salt; and as these plants require a quantity of salt as part of their food, here they are to be found growing just as plentifully as if in their general position by the side of the restless sea-waves. It is worthy of particular notice that at this position—namely at Northwich—the plants are at least thirty or forty miles from the sea; and consequently their being found in this spot was entirely due to its containing that which forms part of their particular food. All *around* the district, the trees, shrubs, and plants were of the usual inland character; but here, where a sea-side saltness existed, there was also a sea-side vegetation. We hope this little anecdote will both strongly impress the fact we are seeking to establish upon the reader's mind, and that its import will be fully comprehended. A number of other instances of the attachment of plants and trees to particular sorts of soil could be mentioned; but these are sufficient to illustrate the point in question,—which, we may be allowed to repeat, is, that besides carbonic acid, ammonia, and water from the air, plants both require and obtain various salt matters, and even earthy matters, in

small quantities from the soil, which form a part of the necessary food of the tree.

It will perhaps be interesting to give one more illustration of the proofs of the truth before we part with it; which we shall do in the following manner. A few years ago, after a terrible thunder storm, in Germany, some persons in passing through a meadow came to a heap of black shining glassy substance, which they were much perplexed about. This mass was taken to the learned men of the town, and caused to them as much perplexity as it had done to the rustics who brought it to them. Some said it was this thing; others said it was that; and the great number of them believed it to be a stone fallen from the sky, of the same nature as those called meteoric stones, which we well know to have done so. After some time it was determined to get a chemist to unravel the difficulty; and a piece of the substance was given to him to try his experiments on, in the hope that he might be able to tell what it was. In the meanwhile the owner of the meadow was astonished to find that a good-sized stack of hay, which he had carefully placed in this very meadow, was gone, nowhere

to be found! Not so much as a single stalk of hay was left, and he had to mourn over his loss without being able to get the least clue to the perpetrators of the damage. Thus matters remained for a time.

At length, greatly to the relief of the perplexed philosophers, and infinitely to the astonishment of the bereaved farmer, the nature of the shining molten mass was found out. M. Gmelin, the chemist, after several experiments, found it to consist not of iron or such matters, like "meteoric stones," but of a substance which forms the *outer coat of grass and hay*, and may be called a sort of compound of sand and potash. Now all was cleared up in an instant:—a flash of lightning had struck the farmer's stack of hay, consuming it in a moment, and leaving only the black melted mass, consisting of the salts and the earths in the hay, which had formed a part of the food of the grass, behind it. Thus was this curious problem resolved.

Now all the glassy coating of a straw, which gives to the bonnets of fair ladies that shining look, is composed of earthy matter forming a part of the food of the wheat plant. Sometimes

we may actually find this earthy matter in the stems of trees, which, like straw, have a polished glassy outer surface—as the bamboo. Frequently indeed in the hollow trunks of this tree, the bamboo, large pieces of it are found, which are like the more friable sorts of stones in hardness, and are called by the name *tabasheer*. It is sometimes called "Bamboo manna," and is still sold in Syria, Turkey, and parts of India as a medicine.

Thus, to sum up what we have said about the proper food of the vegetable subject of our history, —the Tree—we find that it is obtained in several ways. The firm wood was got from the carbonic acid of the invisible air; the valuable nitrogen, which forms the parts of the seeds or fruit most nourishing to man, was derived from the ammonia floating in the air in small quantities; and its juices from the rain descending from the clouds. Besides these, the different saline and earthy matters, which we also find to form a part of the vegetable diet, were obtained from the soil, being received by the plant or tree by means of its roots. So that, wonderful to say, the plant receives by far the greatest part of the material

out of which it is formed, from *the air*,—and not, as we are naturally inclined to believe, from the earth! We have, however, lingered long enough over the food of plants.

While we have been loitering to explain this part of the life of a Tree, a month has made a vast change in the look of our friend. See now the tree is in full dress, and on every branch behold a cluster of sweet smelling flowers! The air around teems with fragrance; and the tribes of insects come in crowds to pay court to the vegetable beauty, and to taste the sweet juices locked up in every flower. Our tree may be thought to be rather late in flower, for the tide of summer has reached its height, and many a Spring-flowering shrub has long since strewn its blossoms on the earth. But we gain this advantage, that the Spring-flowers are mostly pale, and often but feebly scented, while those of these warm and genial days are of a full rich colour, and emit a powerful fragrance, except at night, when they seem to lock up their caskets of scent, only to reopen them with the returning smile of the sun.

This is rather a singular fact,—the difference of

colour in the flowers of various seasons. Spring is characterized by its peculiarly light and fresh tints of colour; Summer, by its brilliancy and variety of contrast; and Autumn, by the subdued and mellow tones in which all vegetable nature seems steeped. These beautiful changes of aspect are, doubtless, connected with some physical cause, and must not be looked at simply as matters of interest only to the eye, or to the artist. As faithful historians of plant history, it becomes us to ask what is the cause of them.

There can, we believe, be but little doubt they are connected with some peculiar difference in the nature and quality of sunlight at these different seasons. Merely to recal to mind the peculiar tones of the sky at these different seasons, would suffice to supply us, after a rude manner, with this conjecture. What early riser but knows the cold, pale, and almost ghastly look of a March morning? and during the day the peculiar whiteness of the sky must be familiar to every observer. In summer, deeper tints accompany the rising and the setting of the sun, and a bright glow seems during the day to rest on every living and inanimate object. Autumn takes on a

tone more deep and full than all; and her skies, like those of the old masters', abound in a peculiar richness of colour, the mere contemplation of which sheds a soft and almost hallowed influence on the mind.

It is not, however, yet positively known what the difference in light here spoken of is really; nor does it appear very probable it will be discovered, at least for some years to come.

Taking one of these most beautiful appendages of the tree in our hands, we may ask, What is the exact cause of the colour so exquisitely inlaid in the striped petals of this flower? Some thoughts, which occupied us on a previous page, will perhaps help us to answer the inquiry. We there found a poor imprisoned potato putting out a shoot in the dark, which was as white as the most delicate flower, but as soon as it crept into the light becoming all of a sudden of a deep green. Why then do not white flowers turn to green when exposed to light? Let the reader call to mind what was said about the little cells which make up the whole structure of the plant. Some of these little cells contain a substance which, when exposed to light, undergoes various changes,

and accordingly reflects either a green, or some more brilliant colour; those parts which are white do not perhaps contain this substance at all, and therefore the white appearance is simply the pure lustre of the tissue filled with limpid juices. It is quite certain the sunlight is the great cause which, as we might say, paints the flowers in all their splendid colours: remembering always the words of our Saviour Jesus Christ, who in telling us to consider the lilies of the field, and that Solomon in all his glory was not arrayed like one of these, reminds us that it is God who has so clothed the grass of the field; and though we may, therefore, certainly say that it is the light which brings all the glories forth, we must also remember it is God who not only said, "Let there be light," but also so created the beautiful tissues of the plant, that when the solar rays fall upon them, they produce all those lovely tinges which so much delight our eyes. Truly, when we consider how much every plant, from the lowest and least of the field to the tallest and strongest of the forest, is indebted to the genial influences of the sun's rays,—had they a voice to speak, they might exclaim with

the sacred writer, "A pleasant thing it is to behold the sun!"

It is very singular that some flowers do not retain the colours they at first appeared in. The most striking instance is a flower called the *Chameleon cheiranthus.* This is at first of a whitish colour, then it becomes of a beautiful lemon-yellow, then red, and last of all, it changes to violet. The tamarind-flower is white the first day it opens, and yellow the second! and the flowers of a creeper, which, from its rapid growth, is a great favourite among the artificial-bower florists around London, the *Cobœa scandens*, are of a greenish white on first opening, and by the middle of the next day have altered to a deep, beautiful violet. An instance stranger even than these, exists in the flowers of another plant; these are white in the morning, pink in the middle of the day, and brilliant red at night. These changes are probably due to a combined chemical action of the air and the light of the sun.

Whence comes this balmy odour which, rising from the flower-crowned tree, fills all the air around with "a pleasant smell?" This is one of

the "hard questions" of botanical science; and we fear we can only say—We cannot tell. There is no doubt it is a chemical process of some kind or other, taking place in the thousand cells which, united, form the flower. The fragrance is most exquisite of its kind, and in its soft and delicate nature is immeasurably superior to those burning, pungent, scented spirits which are called artificial perfume. The morning glittering with the drops of a new-fallen shower, or the dewy close of day are the best times for enjoying the pleasures of the garden; for then, borne on the moist wings of rising vapours, the fragrance of the flowers streams out in richest abundance. Then indeed "all nature seems as if offering up incense in gratitude for the refreshing powers of dew." In the dry and sultry period, called in Scripture language by the expressive term the "heat of the day," the perfume of plants is not to be perceived, or at least with but a very small proportion of the power in which it is poured out when the twilight shades come on. It seems probable that this is entirely due to the comparative absence of moisture in the air at the one period, and to its presence in the air of morning, or of eventide.

Some flowers are quite exceptions to this rule. Thus there is a splendid flower called the *night-blowing cereus*, which is scentless all day, but at night bursts into fragrance, and fills the conservatory with odour. This remarkable flower begins to put forth its delicate scents about six or seven in the evening, and continues almost literally breathing forth perfume until about midnight, when the process ceases, and the flower becomes scentless as in the day. Some of the Pelargoniums and Orchids have the same curious property. These facts only serve to make us more puzzled than ever about the source and cause of odour in flowers. They shew us, after all, how little science knows of the more delicate and minute points in Natural History; and while they may make us more diligent in pursuing our researches, they should also make us more desirous for the arrival of that period when "though now we know only in part, we shall know even as we are known."

The sun is sinking toward the horizon, the evening breeze springs up, and whispers the leaves of the wood to sleep; high in the clear air an army of rooks speeds its straight, undevious

way to the far-distant forest home; the lowing of home-wending kine, with the clear whistle of the ruddy cowherd, comes in wave-like flows through the air; and the watch-dog, shaking himself after his afternoon's half-slumber, announces that he has commenced his sentinel duties by a periodical yelp. It is the approach-time of rest. But what of the Tree?

We have already said, that at this time the leaves rest for the night from their duties of decomposing carbonic acid. But a more singular, because more apparent phenomenon, will be found in taking notice of the general aspect of the tree, and of vegetation in general at this time: they have the very aspect of repose. The field of corn, with its legions of waving stalks, carries all the appearance of its countless blades being asleep. The leaves hang flaccid and drooping, and every ear bends its head as if in gentle slumber. Looking at the tree, a less sensible evidence may perhaps be found in this case; but even here the leaves are less erect and stiff, and the flowers, more sensitive than they, are all shut up, the petals folding over one another, and the tender flower-stalk gently drooping to-

ward the stem, as if to take shelter under the wing of the adjoining leaves.

The great botanist Linnæus first paid scientific attention to this phenomenon, which he called the "Sleep of Plants;" and his attention was first directed to it in a very singular manner. He had received from a scientific friend, the seeds of a beautiful lotus flower, which in due time grew into elegant plants, adorned with some splendid flowers. His gardener, having been absent when they came into bloom, immediately on his return in the evening was taken by his master to the greenhouse, to admire the new and splendid flower. Great was the astonishment and disappointment of both, to find on reaching the spot, that all the blossoms had disappeared! The following morning, on his next visit, all the blossoms were again put forth, and the same evening had again disappeared. On carefully examining the plant, the mystery was all dispelled; for it was found that the blossoms, as evening came on, withdrew from the dim twilight, and folding themselves up, disappeared under the drooping foliage of the plant.

Pursuing the subject further, he was able to

arrange a number of flowers in the order in which they open and shut; and found that many flowers close even in the full blaze of day, while others close at various times from mid-day to sunset. Singularly enough, the flowers are very regular in what we may term their time of going to bed; so much so, that Linnæus contrived a flower-dial, by means of which the time of day might be known, according as the flowers contained in the list were open or shut. It must be mentioned, however, that the flowers depend a good deal on the sun; and if heavy clouds cover over his glorious rays, the time when they open or shut will be deranged. This has been particularly noticed in the time of an eclipse; when it has been found that, misled by the darkness spread over the earth by the obscuration of our luminary, not only have flowers folded themselves up to sleep, but even birds and beasts have betaken themselves to their rest.

There are some exceptions to this general rule. Just as in the ranks of human society, there are fine ladies and *belles* who blossom, so to speak, only at very late hours in the evening, when the commoner folk are all in bed; so among the

flowers, some of which lie asleep when all the rest of the sun-lit world is awake and astir, and only put forth their beauties to the air of night. Dr. Lindley tells us that the *œnotheras* unfold their blossoms to the dews of evening, but wither away at the approach of day. And the splendid *cereus*, from which we lately parted, also only displays its glowing colours and exquisite form in the darkness of the conservatory.

That however, in the generality, the sleep of plants is due to the withdrawal of the sun's rays, is sufficiently evident from some curious experiments performed by the French botanist De Candolle. He found that he could reverse the order of opening in flowers, by means of artificial light, and caused those which he experimented on to close during the day by keeping them in the dark, and to open at night by exposing them to the blaze of lamps and candles. We are unable to explain how light acts in this remarkable way; and from the exceptions just mentioned to the general rule, we can only conjecture that it cannot be altogether due to the influence of light, but that some other cause must exist, which has something to do in the production of the

phenomenon. Perhaps it is in some manner connected with the very peculiar vegetable function of which we are now about to speak.

This is called irritability. There are many points in which a sort of similarity between plants and animals may be traced, such as the motion of their juices, their functions of respiration and digestion, and in the formation of their different tissues; but one point is denied to the vegetable world by almost universal consent—the power of motion. Perhaps we shall succeed in shewing that even this must now be given up, and that plants, in some instances at least, are really possessed with a notable, although limited power of moving their various organs. Indeed if we were to look at the very meanest plants, which are of a size only to become visible to the eye with the aid of the microscope, we might lay our finger on some which cannot be distinguished in many respects from minute animalcules, but are able to move about from place to place, yet in every other particular resemble plants. In the higher plants, such as trees, &c. we have nothing of this sort to tell of, from the reason that they are necessarily tied to a certain place by their

earth-embracing roots, and hence they have neither the power, nor probably the instinct, if we can say so much about a tree, to remove. But we have no doubt the singular movements of which we are about to speak, will equally interest the reader.

The sensitive plant, *Mimosa pudica*, is a well-known instance of these singular movements. If one of its tender leaflets is gently pinched, the whole plant seems to resent the injury, and all the leaves of that branch first fall low and droop, and this extends itself, if the touch is pretty sharp, through every branch and leaf, until the plant droops from head to foot. It does not recover itself for some time afterwards. De Candolle informs us of another plant, somewhat resembling the sensitive plant in this respect. It is a native of Senegal, and is called by the inhabitants, the "*How d'ye do?*" plant, because, when touched, its leaves bow down as if about to salute those who touch them. He also relates another equally singular instance in a plant, a native of Dominica, and called, from its peculiar movements, the *Sentinel* plant. While all the other leaves are bent down, one is sure to be found erect, and as

if on the look out for an enemy. After a certain time this leaf comes off guard, and then another slowly rises up and becomes sentinel, and so on through the entire plant! Some of the wondrous flowers of the orchid tribe display a class of movement equally interesting. Thus we read of one, discovered by Mr. Drummond, growing in the Swan River Colony, the flowers of which form a perfect insect-trap in the form of a box with a moveable lid. The poor flutterer, enticed by the odour and lustre of the flower, greedily plunges into its painted dungeon, and that instant is locked up safely by the lid dropping upon it. By-and-by, however, the flower seems to relent, and gradually opening, allows the insect to escape, with no other harm than a good frightening.

We cannot say that the remarkable plant called Venus's Fly-trap is equally merciful. This plant is a native of Canada, but is to be found as a curiosity in some of our large conservatories. Its leaves are formed in a very remarkable manner. They are armed with sharp teeth on the edges, and are able to close together, exactly like the two springing pieces of a rat-trap. The thoughtless insect, tempted to rest on the green

surface of this leaf, is instantly not only captured but often squeezed or pierced to death by the two sides of the leaf springing up and clasping it between their cruel embrace. The English Fly-trap, the Sun-dew, a tenant of the bog and marsh, has the same class of movements, catching its prey by the viscid, birdlime-like juice which exudes from the hairs on the surface of its brilliant red leaves,—and subsequently the leaves fold over the prisoner, Some curious experiments have been made with a view to ascertain whether this peculiar property of seizing upon insects was connected with a taste in the plant for such a sort of food, and a Venus's Fly-trap was fed with pieces of raw meat, and it was actually found that it thrived better than one which had no such supply of animal food!

The flowers of the common berberry-plant, and of the geranium, when carefully examined, have been frequently found to possess very curious movements in some of their parts. And those of another genus will, when provoked by a fine-pointed instrument, cause their central organ or column to fling itself violently from one side of the flower to the other.

For our last and most surprising instance, we must transport ourselves in imagination to the fertile banks of the mighty Ganges. Little wonder indeed if here we find things marvellous and strange, when we consider the exuberant fertility of the rich soil, ever moistened by the sacred waters, and its vegetable offspring nurtured under the animated influences of a tropical sun. As the overpowering floods of light and heat, pouring down upon us from on high, are too much for us safely to endure, let us seek rest and shelter under this broad-leaved tree, whose meandering roots bury themselves deep in the soft mud forming the river's edge. The great stream rolls smoothly down, and seems the emblem of the course of the river Time, quietly rolling itself into the eternal ocean; and like it, alas! carrying down, even before our eyes every now and then, the floating body of some poor Hindoo, who, with baseless dreams of heaven, casts himself to perish in the waters. But glancing our eyes along the bank on which we rest, what vegetable curiosity is this? A dancing plant!

It is even so. Seated in a shady recess,—for

the plant loves not the unshorn brilliancy of the sun's rays, however much dependent on its heat,— is the famous *Desmodium*, or *Hedysarum gyrans*. Let us watch its movements. Its leaves are subdivided into two little oblong ones at the side, and one large leaflet in the centre. The movements take place in the little leaflets, the other being less actively moved. They are of a very odd description:— First, one of these little organs rises by a series of little jumps like the minute-hand of a watch, until it has reached a certain height, then it begins to fall, and the opposite one rises in its place, and so on alternately; but the mid-leaflet is not altogether quiet, we see it first move a little to the right, then a little to the left. These motions are, however, very gradual and even slow in comparison with the others. If we count the movements of the little leaflets, they resemble, even in point of time, the minute-hand motions of a watch, for they are about sixty in the minute! During the whole period of our stay by the side of this wonderful plant, it has never ceased these dancing movements; and though we were to linger there during the night, and watch morning in, should we find

it for a moment at rest? Neither night nor day, nor youth nor age, affects the movements, and they are only arrested by disease, cold, or death. This singular instance of plant-motion is quite without a parallel in the entire vegetable kingdom.

These facts cannot be explained by any one. We know neither the mechanism of the movement, nor the exciting cause thereof. In animals there is a beautiful apparatus which can easily be understood, consisting of muscles, bones, and nerves, by means of which all the wondrous movements of the animal frame are readily effected; but no such, nor even similar apparatus, is to be found in vegetables. The microscope may one day tell us how they take place, but we fear it will be some time ere this is accomplished.

Often, while pondering on such things as these, or when beholding the fresh luxuriance of a vegetable crowd after a new-fallen shower,—a time when every power of life seems awakened, and, as one may say, we can "almost see the plants grow," has the thought arisen, do these beautiful beings enjoy anything like feeling: are they in any measure sensible of what goes on around them, whether, for example, there is better food a little distance

off, or whether higher up in the air there is more sun and less shade? Here again we are left in darkness: Wordsworth, it is true, says,

> "It is my faith that every flower
> Enjoys the air it breathes."

But science cannot prove the poet's words to be correct.

Are we then to consider our Tree as a being without anything like instinct? No!—and we think we can establish some sort of a claim for it on this score, if not on the other, by relating some remarkable incidents, which seem to lead us to the conclusion that plants really have a low and feeble sort of instinct.

We may ask, indeed, had instinct nothing to do with the potatoe stem in directing its struggling efforts to reach the hole at which light poured into its dark prison? But the following are far more striking cases. Travellers in the Indian Archipelago have described a curious tree, called the Screw-pine, which performs a very interesting action. We have been eye-witnesses to the same fact, and can therefore vouch for its accuracy. The tree is supported a little way

from the ground by a number of thick roots, which uphold the stem in the air: this curious

THE SCREW-PINE.

(The prop is seen at some height above the other roots.)

structure naturally makes the tree less able to resist the strong efforts of the wind to throw it down; and, wonderful to say, the tree seems to

be sensible of its own weak points. For if it leans to one side at all, and thus becomes in any way in danger of falling, it immediately puts forth a root from that side of its stem, at some height from the ground, and this reaching the earth grows vigorously, and becomes a firm, strong buttress to the tree, so as perfectly to avoid the danger. This is nicely represented in the accompanying cut. If a human architect had been commissioned to prop up the tree, he could not probably have managed it better.

Sometimes trees will actually send a root across an abyss or chasm, on the one side of which they may happen to be growing. After growing for some time they begin to find a lack of food in the spot where they are fixed; and, whether by instinct or not, we cannot tell, but at any rate perceiving that on the other side of the ravine there is a good supply of rich earth, they send out a pioneer in the shape of a root, which bridges over the gulf, and in the event actually conveys along its countless tubes the food it finds on the other side, back to the parent tree. Often we may see something of the same sort in our strawberry beds. When one of the plants grows near the

walk, it will often put out a long wire-like runner quite across the gravel-walk, and enter the earth on the other side, where it begins to put out an abundance of roots. We frequently

A TREE IN SEARCH OF FOOD.

also read of plants stretching out their stems to a pan of water, and as it were following it wherever it is placed.

In the lower animals we consider it a sign of instinct, if a creature avoids a certain kind of food which is calculated to injure it if swallowed. Shall we deny then instinct to the tree, when we find it behave almost precisely in the same manner? Dr. Daubeny has made a number of experiments on this subject. He watered plants for a long time with water containing in solution a chemical substance likely to injure them, but the plants refused to absorb the least trace of it, nor could it be found that any had got even into the inner tissues of the root. Even when watered with coloured water of an innocent kind, they seemed to have the power of absorbing the pure water and leaving the colouring matter behind.

But, just as the instinct of the lower animals often fails them, and they will take food which may cause their death, so with trees and plants also. Experiments, for instance, have been made upon the sensitive plant by M. Macaire. A leaf of it was placed in a cold solution of opium, and, after remaining in it for a few hours, became quite insensible to the sharpest concussion, it would contract no more, it seemed overpowered as it were with sleep, and soon died. Now such are

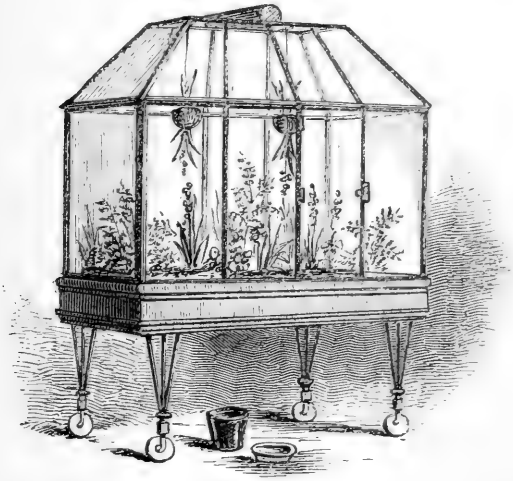
exactly the effects of this poison on an animal. Prussic acid, one of the most terrible poisons known, also paralysed the poor plant; and, however it might have been shaken, it refused to shew any of these signs of sensitiveness, which were previously manifest in it. Solutions of other poisons produced much the same effect on plants as they do upon animals; the poisoned trees soon perishing and withering away.

Plants have also been exposed to different kinds of gases, and it has been found that those which destroy animal life, have the same effect upon that of vegetables. Perhaps one of the reasons why plants will not thrive in London may be, that the smoky filthy air of the metropolis acts as a sort of poison to these tender beings. Something of this kind must be the cause of their drooping, withering, and dying, in spite of the greatest attention paid to them, as soon as ever they leave the pure and healthful atmosphere of the country for that of London. In Paris less impurity of the air exists, because there is little or no coal burnt, the fuel being chiefly wood and charcoal; and here we have often been struck with the freshness of the flowers in poor persons'

windows. Just opposite the hotel where we stayed for some time, was one of the prettiest flower-decked windows in the world. Rich green creepers clustered up each side of the window, and met in a graceful arch above, from which their painted blossoms hung elegantly down; and on the window-sill was a box as full as it could hold of all sorts of flowers, the sweet odour of which wafted country remembrances into the room at every breath of air. All these plants seemed as strong, green, and healthy, as if, instead of growing in the very heart of the metropolis of the empire, they had been luxuriating outside some cottage door deep in the country.

Mr. Ward, a surgeon in London, has contrived a very pretty miniature conservatory, in which, even in London, plants may be grown of a small size, in all their country freshness. These cases are made of glass, and are constructed so as to fit down over the plants, and in a great measure exclude the air. The plants are placed in some good mould in a tin box with gravel at the bottom, and are then properly watered *once*, and the glass cover is put over them. They will now grow luxuriantly, and do not require watering

again for a very long time, as the moisture condenses on the side of the glass, and runs down to the earth again. Ferns and mosses grow in beautiful clusters here, and when the boxes are nicely made, they form one of the most beautiful ornaments possible for a lady's drawing-room.



One could almost fancy it was a great conservatory, so completely do the forms of some of the plants often grown in these cases resemble those of large trees. Probably *one* great reason of the success of this little contrivance is the fact, that little of the external air can get into it to injure

the delicate inhabitants of this tiny vegetable world.

But to return to our immediate subject. May we not then put in a plea for the possession of a *sort* of instinct for our tree? Undoubtedly, it is nothing to be compared to that of animals; but is it nothing at all? Surely the few instances we have brought forward seem to say in loud tones, that dim and indistinct as this faculty evidently is, it is going too far to say it does not really exist. If we admit the probability of its existence, what interest does it not give to our contemplations of the Life of a Tree! No longer do we speak of a mere wooden machine, which Spring sets in motion, and Winter lays to rest. The tree is no longer regarded as but a little above a rock or a stone. Whether we look upon the favourite plants of our own choice and under our own care, or upon those that inhabit our gardens, or those which form our woods and fields, we now see vegetable beings, which even appear to enjoy a low measure of happiness, to whom it is not an indifferent thing whether the skies are ever fair and unbeclouded, or frequently darkened with storms, or dripping with rain. It is true they are unable

very evidently to shew their sensations, if they have any; but it is equally true, that some of the lowest animal tribes are not superior to them in this respect. If it has pleased God in their creation really to endow trees with this faculty, undoubtedly it is a gift of love, to enable even this portion of His wondrous works to find happiness in its being alive; and knowing how widely the Great Creator has extended the power of enjoyment among even the humblest created beings, the supposition that it has been granted to plants also, may be considered as not one of the most improbable in the world.

Not only are we accustomed to think of plants as insensible beings, but we are also apt to consider them as not possessed of any heat proper to themselves, like animal heat in the animal world. And perhaps it can be shewn that this is an erroneous impression, as well as the other. If we expose a glass bottle full of water to a sharp winter's frost, even after taking the precaution of covering it with flannel or straw, the water will, in all probability, freeze, and burst the bottle; yet the stem of many a young tree exposed to the same penetrating cold, and also charged with fluids

that would easily freeze, remains uninjured, and it is found that only the young shoots are generally frozen through, even in the severest frost. Surely, then, the tree must have some source of warmth which can enable it to resist the cold of a winter's night, and all the long frosts of that season too! This may be very prettily shewn also in the following simple manner. On a frosty day in Spring, take a small piece of ice and lay it on the bud of any tree which is just beginning to wake from the Winter's sleep, and place a similar piece of ice on a piece of wood, close by the tree, so that both pieces are in the same condition as to external temperature. It will now be found that the piece of ice on the bud will slowly *melt away*, while that on the piece of wood remains unmelted. Evidently, therefore, the tree is warmer than the dead wood. Some experiments on this much neglected subject, have shewn the interesting fact that the tree is actually three or four degrees of the thermometer warmer than the air surrounding it.

M. de Saussure noticed the curious fact that snow melts more quickly around the trunk of living than around that of dead trees,—a circum-

stance which might be explained on the supposition that the living tree actually possessed a power and source of internal heat. John Hunter seemed to prove it still more satisfactorily; for he caused a hole to be bored into the trunk of a tree, and placing a thermometer in it, he found that it stood two or three degrees higher than one exposed to the air.

M. de Candolle has offered an ingenious explanation of these singular facts. After mentioning the experiments of some other authors upon the subject, in which it was found that thermometers buried in the earth at the foot of the tree, indicated the same temperature as the trunk of the tree, he comes to the conclusion that it is because under the surface of the earth the water in the soil is actually warmer than the surface, as it is well-known to be in Winter, and because this water rises into the tree through the roots, communicating its warmth to the wood through which it passes, that therefore the interior of a tree is warmer than the wintry air around it. In other words, he believes that trees have no source of internal heat of their own, but derive their warmth from the soil in which they grow.

The subject, it must be acknowledged, is one of great obscurity.

Arum Maculatum.

At the time of flowering in some trees and plants, there is a very remarkable evolution of heat, which we shall be better able to account for. It will surprise many readers to learn that, when some plants are just expanding their flowers, these beautiful organs became quite warm. The curious plant here figured, the *Arum*, presents us with one of the most marked cases in point. One of the species growing in the Isle of France was found, upon experiment,

to make a thermometer placed inside the fold at the bottom of the flower, rise to the temperature of 121°, while the warmth of the external air was but 66°. M. de Saussure, in some experiments on the flowers of the gourd, Bignonia, and others, found the same results in smaller quantities; and others have with several other plants obtained an accumulation of similar facts.

As must be evident, the heat disengaged is soon lost in the air; the reader, therefore, must not feel disappointed if he cannot succeed in detecting it. The common *Arum*, or "Cuckoo Pint," or as children call it, "Lords and Ladies," very common on every hedge-bank, seems to offer the best chance of success; but he will require a very delicate thermometer even then, to find out any notable increase of warmth in the flower, and care must be taken that the experiment is made just at the right time, when the flower is expanding. Perhaps, if a fold or two of fine flannel were wrapped around the flower, the little thermometer being carefully plunged into the heart of the flower, the rise of the mercury might be made more apparent, as this would prevent the external air from cooling the plant.

The cause of this singular phenomenon is well ascertained. We have already seen that the green parts of plants absorb carbonic-acid gas under the influence of light: now, it is a remarkable fact that flowers, on the contrary, drink in pure oxygen gas; and it is found, that just in proportion as a flower consumes this gas, its heat rises or falls. Thus, while other flowers only consume eight parts of oxygen, the *Arum*, in which we have seen the heat was most manifest, consumed *thirty* parts.* As chemists well know that no substance can unite itself to oxygen gas, without producing heat, this is without a doubt the cause of the evolution of the heat in question.

Although the thin bright edge of the young moon rises higher and higher, warning us that while we are lingering to tell of all the curiosities of and in connection with the tree's history, the hours are rolling on; yet the warm still air of the midsummer evening, all fragrant as it is with such a mixture of sweet odours as

* In a common fire all the heat we feel arises from the oxygen gas of the air uniting itself to the coal; and though the heat of these flowers is feeble, it nevertheless is due to the same cause, which is indeed commonly called *Combustion*.

only could arise from Nature's own combinations, has charms for us, which for a little while longer will detain us in the open air.

What is that little pale glow of light resting on that bed of marigolds, like the "glory" on the heads of saints, pictured by the old masters? Can plants emit light? So strange is the idea that unless actually witnesses of the phenomenon ourselves, we could scarcely believe it true. Nevertheless, there is the light. The marigolds are undoubtedly the producers of it, for neither glow-worms nor other luminous insects are to be found. What have we to say, then, as to the luminosity of plants?

The Fungi, as we have already had occasion to notice, are not unfrequently splendidly luminous; but, as we then saw, they are in other respects the complete exceptions to the rest of plants. The daughter of the great Botanist of Sweden, Linnæus, appears first to have noticed this strange phenomenon. She observed that the flowers of the *Nasturtium*, the marigold, and others of an *orange-colour*, emitted light at the close of a warm Summer's day. The following singular fact is even more striking:—"In the garden of the

Duke of Buckingham at Stowe, on the evening of Friday, September 4, 1835, during a storm of thunder and lightning accompanied by heavy rain, the *leaves* of the flower called *œnothera macrocarpa*, a bed of which was in the garden immediately opposite the windows of the Manuscript Library, were observed to be brilliantly illuminated with phosphoric light. During the intervals of the flashes of lightning, the night was exceedingly dark, and nothing else could be distinguished in the gloom, except the bright light upon the leaves of these flowers. The luminous appearance continued uninterruptedly for a considerable length of time, but did not appear to resemble any electric effect."

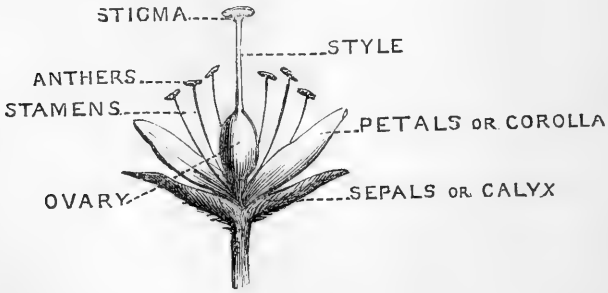
A more wonderful example than either of these was brought before the notice of the Asiatic Society of London. The luminous plant was discovered near the foot of the hills in the Madura district in Hindostan, by a native, who, having been compelled by rain to take shelter under a mass of wood in the jungle, was astonished to find all the grass in the vicinity blazing with a pale phosphorescent light. Even the dead fragment presented to the Society, although not

luminous while dry, became so after it had been wrapped in a wet cloth for some little time. The piece then shone in the dark like a piece of phosphorus, or perhaps with more paleness of light, more like dead fish or rotten wood. Dr. Lindley says: "We advise gardeners to be on the look-out for this phenomenon, and to examine all such root-stocks as they may have in their possession, in the hope of finding it. Plants habitually luminous, and constantly so at night, and retaining their properties years after they are dead, and capable of being cultivated as this Madras plant most certainly is, would form quite a new feature in our gardens, and are well worth any degree of trouble that may attend their discovery."

Botanists have not come to any agreement yet as to the causes of luminosity in plants. The light of decaying wood is due to chemical decomposition, but it does not appear that the instances of luminosity just narrated are to be explained in the same way. It has been supposed that occasionally they are connected with electricity.

Our next visit to the tree must be by daylight, if we would learn anything of the functions of those sweet-smelling organs, the flowers.

On examining a flower, we find there are generally three separate parts of it which deserve our notice. First, there are the beautifully tinged outer leaves, called *sepals*, and inner ones, called *petals*. Secondly, there are a number of delicate little thread-like bodies, called *stamens*, with little yellow pieces on their tops, called *anthers*. And, thirdly, in the middle, is an upright little piece, called a *style*, bearing a head called a *stigma ;* and a swelled part at the bottom, called the *ovary*, or receptacle for the seeds. All these can be very nicely seen in the geranium, or in the large white lily growing in our gardens. They are also clearly shewn in the cut.



Now, in order to perfect the seed of the plant, and so to furnish mankind with the means of

growing many more plants of a similar description, it is necessary that certain processes should take place in the flower, which are very simple and interesting. If the little pieces we have called *anthers* are carefully examined, particularly if they are looked at through a small magnifying glass, they will be found to be sprinkled over with an immense number of very small grains, which to the eye look like so much yellow powder: this is called *pollen*. Before the little seeds placed in the ovary can be ripened or made fit to grow, it is necessary that these little yellow grains on the anthers should fall upon the piece called the stigma; and could we watch with the naked eye the events which take place, we should find that this actually comes to pass. After falling there the yellow pollen grains have been found to put forth a little tube each, which pierces the tender cells of the stigma, and then seems to enter into the seeds contained in the receptacle or ovary below.

There are, however, many plants the flowers of which do not contain *both* stamens and a stigma. In these, the stamens are in one flower, and the stigma in another; and these may even grow on

separate trees. Then comes the question, How is the yellow powder to be carried from the one to the other? Unless it is conveyed in some way or other, the seeds will never ripen. This difficulty, in common with every other of a similar kind in creation, has been beautifully provided for by God, who, when He created the world, and its animal and vegetable tenants, knew the "end from the beginning," and ordered all things so as to accomplish their proper parts in His all-wise plan.

The answer may well excite our surprise. The important yellow powder is carried from the one to the other, chiefly either by the winds or by insects, and sometimes by man himself. Doubtless the hairy coat of the industrious bee was a special contrivance, intended, among others, to effect this end, which is of so much consequence to plants. Mark how the ever-industrious insect plunges into a flower, and is for a while lost in its painted recesses. After buzzing about for a few seconds, see her emerge as dusty as a miller, all powdered over with the yellow pollen. Away she flies. The next flower to which she wings her way, is perhaps one that only possesses a stigma; and

here, in entering, she rubs her dust-covered coat upon this organ, overlaying it with the very powder which is requisite for it.

When the wind is the pollen-carrier, it is in consequence of the pollen-grains being so light as to float upon a gentle breeze, and they are thus conveyed to their proper destination.

Sometimes, however, man is the instrument. The Date-palm is just one of those trees in which the flowers are either of one kind or of the other, and unless the pollen-grains of the one are in some manner or other conveyed to the flowers of the other, no dates would be produced; for, as we have just remarked, the seed will not ripen unless this is the case. Now a failure of the Date-harvest would be, to the inhabitants of Lower Egypt, as serious a calamity as the failure of our Wheat-crops to us, since they subsist mainly on this fruit. They therefore go and pluck the flowers bearing pollen, and climbing the trees of the opposite kind, sprinkle the yellow dust over the flowers which possess stigmas. After this, they are tolerably sure of a fruitful harvest. In the year 1800, when the French armies invaded that country, the wretched natives fled away in all directions,

and could not therefore perform this necessary operation. The sad result was, that all the Date-palms in Lower Egypt were barren that year, and a Date-famine was the mournful addition to the horrors of war. Our gardeners often perform the same manœuvre when they wish to increase the fruitfulness of the cucumber or gourd.

De Candolle tells us of a pretty little French *fête*, which had its origin in this operation. It was at *Saint Valery-en-Somme* that there grew an apple-tree, which by some singular accident, instead of producing flowers containing both the pollen-grains and the stigmas, only bore flowers with stigmas, and was therefore barren for some time. At length the cause was discovered, and it was proposed to take the flowers of another apple-tree, and sprinkle the dust over those of this tree. The result was crowned with success, and on its being repeated every year, the little *fête* was established; and amid the usual accompaniments of a little procession, music and dancing, and the merriment of all the young men and maidens of the village, the branches were waved over the tree, and they returned again to the village. The name of this festivity was *Faire*

sa Pomme, the literal English of which would be "making one's apple." We should perhaps have called it, had it been one of our popular customs, "The Apple Feast."

When, in the flower, the pollen has been thus applied to the stigma, a great and often very sudden change takes place in the flower. As if conscious that the end of its existence was now accomplished, it shrivels up, withers, and generally drops from the tree, shedding its beautiful petals upon the ground to rot and crumble into dust. The ovary then swells, and with its contained seeds, becomes the *fruit*.

As every one knows, the fruit undergoes great changes as it ripens. If we look at an apple just as it begins to be formed, we find it to be a very different object from that which, when ripe, is perhaps our favourite dish at dessert. Now, it is a hard, woody, sour, or tasteless knob of tissue, which we are well content to let remain on the tree until it lose all these characters. Then, it has become a juicy, soft, well-formed, and deliciously flavoured substance, tinged in many instances, as in the American Lady Apple recently introduced into our fruiterers' shops, with

the most brilliant contrasts of the richest colours, golden and deep red. Disregarding other changes, the most remarkable alteration to which we are called to attend, is that which we all prize so much, the change from intense sourness to a delightful sweetness of taste. How is this accomplished?

It has been found, that while the fruit is green it acts upon the air in the same manner as the leaves,—that is, it absorbs carbonic acid during the day, and exhales it at night. As it becomes more and more ripe, peculiar chemical changes take place in it, and the juice it contains gradually becomes more and more charged with sugar, until at length it is full ripe, and it then loses its connection with the tree, and falls to the ground.

After it is ripened, in a certain time it begins to rot. The oxygen of the air acts upon it, and reduces it to a soft pulpy mass; except the seeds which are contained within, and which seem to have been beautifully endowed with a peculiar power of resisting this change. In the common medlar, this rotting is commonly allowed to take place, and the fruit is not eaten until it has

quite rotted;* but most other fruits are spoiled for human consumption by the change.

If we can shut out the oxygen of the air, therefore, we shall generally be able to preserve our fruits for a considerable time; and our housekeepers are acquainted with many ways of so doing, all of which have this particular object in view, although probably the *science* of their operations may be unknown to them. Thus a favourite plan is, to put half-ripe fruit into a dry bottle, cork it up, wax over the cork, and bury it in a garden. Many a time have we thus the pleasure of seeing the fruit of the last season come up to table in different forms of cookery, as fresh as if just plucked from the trees. Another plan is, to put at the bottom of a bottle a paste formed of lime, sulphate of iron, and water, and afterwards put in the fruit, but with some little contrivance, such as a layer of cork over the paste, to keep it from touching the fruit. The bottles must then be well corked and waxed over. This paste acts in a chemical manner on the air contained in the bottle, and takes from it all its oxygen gas, so

* This change is also called "Bletting."

that there is none left to attack and injure the fruit.

Both fruit and flowers may be preserved also by means of cold, which seems to act by preventing chemical decomposition from taking place; as it is well known that chemical changes of this kind require a certain degree of warmth before they can be set going.* In France, where flowers in particular are great favourites with the people, they are preserved in icehouses. They are gathered before they have expanded, and are put into glazed jars perfectly clean and dry, and over which a tight capping of oiled silk is to be tied, so as to exclude the air. These jars are then placed in the antichamber of an icehouse, where the temperature is nearly about that at which ice melts, for were it colder the flowers would be frozen. When wanted, they may be made to unfold their blossoms by plunging them into luke-warm water; the fibres soon resume their natural pliancy, and if now placed in a warm room, the stems being plunged in tepid water, they will expand and appear as fresh as if but lately culled from the garden or the hot-house.

* Apples are sent from America to the East Indies preserved in ice.

Autumn has now come. The tree forms no more wood, and having, as we have seen, in succession put forth its leaves, flowers, and fruit, little now remains for us to say concerning it, before the arrival of the Winter of the natural season, and of the Winter of vegetable old age; but this little is both important and interesting. After the month of August, trees form no more the woody bands, of which we have before spoken, and which form the *concentric ring-marks* noticed at the commencement of this chapter. The tree is not, however, inactive. Its leaves still continue in activity, though with diminished powers; but instead of forming wood, they now form *starch* out of the food they obtain from the air and the soil. This starch is stored up in cells throughout the whole tree, sometimes accumulating more in one part than in another. It is intended not for the use of the tree itself, but generally for the nourishment of the young leaves and branches of the next Spring.

The starch thus deposited in the trunk of the tree, sometimes is extracted by man for the purpose of food. Thus we are told that bread is made from the bark of pine-trees in Sweden

during famines. The pith of old palm-trees is often so rich in a variety of starch, well known to all under the title of sago, that the inhabitants of the countries where it grows fear little the effects of a famine of other produce, if they can only cut down enough trees; for these supply them abundantly with good, cheap, and nourishing food. The finest sago is prepared from palm-trees forming immense forests on nearly all the Moluccas, and so rich in sago, that each tree is reckoned to furnish from six hundred to eight hundred pounds of this useful article; other palm-trees, after yielding an enormous amount of sugar from their sap, are cut down when no more will run out, and, by proper means being employed, as much as from a hundred and fifty to two hundred pounds of sago may be obtained from the trunk.

Here let us close our chapter on the history of the Adult Tree.

THE OLD AGE OF THE TREE.

CHAPTER IV.

THE OLD AGE OF THE TREE.

FIVE hundred years have gone by, yet the Tree stands. A thousand times have the storms of heaven wrestled with its sturdy trunk and wide-spread limbs, while the earth trembled at the contest; five hundred Winters have bent down its long and crooked branches with a huge load of snow, and more times than we can mention have huge branches withered, died, and dropped off. Yet the Tree stands. But how altered in its aspect from the tree as it first appeared before us, a tender, fragile, graceful sapling, and then a ripe young tree! All the lines of young grace and beauty are gone, and with them the pliancy of the sap-charged stem. The great trunk is now a great tower of wood, covered with huge knots and warts, and furrowed into deep channels, down

which the rain gushes violently after every shower of long continuance. The great branches which jut out from its sides, are full-grown trees in dimensions, and as thick as the united bodies of two or three men; and every here and there we may see a huge round stump all covered over with mould, and perhaps forming a little garden of itself, bringing forth divers kinds of weeds and grass high up in the air, where former branches grew, and were cut off by the woodman. The earth round about is all knotty and raised up into mimic hills by the great swollen roots beneath, some of which are, indeed, bare and exposed, and are polished with the gambols of children playing about them, and by the rubbing of the beasts of the field against them, when they come hither for shelter from the mid-day heats. A terrible and majestic object is that great old tree in the Winter time, particularly when it is seen in a snow-storm. Then to watch it at a distance,—to see the big, burly branches fight, with their hundred arms, with the whistling wind which pelts it and blinds it with a cloud of snow, —to see it stand without a quiver in its stalwart trunk, when every tree of the field bows submis-

sively to the invisible giant of air, when the tall poplars come lowest of all, and feel, together with mighty ones of our own race in the whirlwinds of life, what a dangerous thing it is to carry it loftily in the world,—and to hear every now and then the crash which tells that some rotten-hearted member has been snapped off in the fight,—this is something worth experiencing!

Yet the Tree stands,—and lives a hale and vigorous tree still. Three hundred years agone old men out of the village used to come and poke the old trunk with their sticks, and prophesy, "Ay, ay, it couldn't last much longer." A hundred years later, their children's children, themselves white with age, used to do the same; and in their turn were laid in the grave. And now a hundred years later still, behold it living and strong, while the old men, and generation after generation of their descendants, are crumbled into dust, and their grave can scarcely be found in the moss-covered corner of the churchyard.

That it is really and truly alive, the return of Spring will not suffer us to doubt. Green leaves, as fresh and young as ever dangled from its

branches in its early time of youth, are seen for the five hundredth time dancing in the brisk air; their tone deepens with the advancing year, and all their functions go on as well and vigorously as ever. In Scripture language "it takes deep root, it fills the land. The hills are covered with the shadow of it, and its boughs are like the goodly cedars. It sends out its boughs to the sea, and its branches to the river."* Even in its old age it is "fat and flourishing."†

But let us take a nearer view of this apparently hale old tree. Look at it in the Frontispiece too: approaching it on another side, it appears a mighty, solid mass of timber; but on this, we perceive a great hole completely through the tree, large enough for the entrance of two or three men. We may step inside the tree, and there is room for a party of seven or eight in its capacious recess. The shepherd well knows the spot, and often drives his flock to lie down under its broad shadow, while he himself ensconces himself in the wooden room within the tree; leaving his dog as sentinel and guard, whilst he betakes himself to a quiet sleep. On touching the sides of this singu-

* Psalm lxxx. 9, 10, 11. † Psalm xcii. 14.

lar apartment, we find the wood all soft and rotten, and we may break large pieces off, even with the unassisted hands. On rubbing these pieces between our fingers, they crumble to powder. Had we not seen the green clothing of the vigorous branches outside, we could have guessed at nothing less, on contemplating the interior, than that the old tree was in reality dead. Outside, truly, there is a fair show of strength and vigour; but to look within, there is nothing but rottenness and fast advancing death. How can this be? Can the tree be dead and yet alive at the same time?

This singular circumstance may be accounted for without difficulty. We have already seen, that from the very first, in the trees called Exogens, the different concentric layers of wood were laid on to the tree from *without:* by this it is to be understood that the new wood was always added to the outside, it being deposited just underneath the bark. Consequently the process of growth is chiefly on the outside of a tree; the inner portions of it being of use chiefly to give stability to the structure, and to circulate the various nutritious juices, convey-

ing them from place to place in the stem. Hence, it is not actually necessary that the trunk should be perfectly solid, so long as enough wood remains entire to perform these two functions. The mere fact, therefore, that the trunk is hollow and time-eaten, even to a very large extent in the centre, is of but little consequence to the life of the tree. As it is well known that a hollow pillar is stronger than a solid one, there is no fear on the score of weakness, unless the internal decay proceeds at a very rapid rate. And so long as a sufficient amount of woody tissue remains in the circumference to carry on its usual duties, there is little fear of the death of the tree. The branches with their ten thousand workmen, the leaves, are continually condensing fresh wood from the very enemy the tree has most to fear—even the tempestuous air. Not a wind that howls through its boughs, rustling with the quaking leaves, but parts with some portion of its contents to contribute to the strength and endurance of the venerable trunk, with which it has so long vainly contested. Not a drop of rain that falls in pitiless fury upon its aged

head that does not find its way into its wide-spreading roots and enter into the various tissues to nourish and support them all. The once solid fortress whose barely recognizable ruins lie yonder half hidden with grass and weeds, five hundred years ago might have laughed to scorn the idea that the young sapling, then rising from the soil, was destined better to brave the tooth of time than it, although built of masses of rock, cemented with consummate art, and bound together with clamps of iron. And wind and rain might have thought the fortress a far more invincible object of attack than the pliant young tree. But wind and rain brought nothing with them to add to the fortress, and never left it without taking much away that could never be restored again. Time went by: the strong-built castle grew crazier and began to crumble away; the hard cement was washed out of its joints, and the great stones grew insecure in their places, while the tree lived on, and year by year increased in stature and in strength, until its topmost boughs waved high above the castle-tower. Three centuries had not elapsed: the fortress was in ruins;

and claimed as its only occupants the plants which sprung up in its once merry hall, and the cawing rooks, which took a particular fancy to live in its smokeless chimneys. Yet the tree lived on, and the wind and rain fought as before with a foe to whom they themselves communicated strength and resistance. Now where is the castle-tower — where the massive wall, the lady-chamber, and the banquet-hall? The green and smiling earth covers their remains; and the great tree looks mournfully and in vain for the mere remnant of a building, that in its youth seemed strong enough to last out all time!

Let this thought give courage and strength to ourselves. Has God so strengthened the trees of the field and enabled them to gather force out of the very storms which threaten to uproot them, and is He less mindful of us, his creatures? No! if it be so that we are one with Christ, joined to and abiding in Him, "who is the True Vine," we are safe. A thousand storms may rage around us, they cannot tear us from Him: nay more, they themselves cause us to cling closer to Him; and thus,

when the fury of the adversary is "as a storm against a wall," far from hurling us to the earth again, it is the very means by which our strength comes to us, and is increased continually in us. But be it also ever ours to remember that "we bear not the root, but the root us;" and that the root which bears us, is none other than our Lord and Saviour Jesus Christ; for, severed from Him, we are, and can do, nothing.

It appears probable that there is really no fixed limit to the age of a tree formed on the Exogenous plan, where the youngest part is outside; for with every year, it continues to become strengthened with new and young material so as to counterbalance the decay which goes on in its interior. Notwithstanding this source and cause of perpetual youth, the events and accidents of rolling years write upon the stoutest of the vegetable children of the earth, "Thou, too, art mortal." The change which influences every earthly object affects the tree likewise; and as we shall see in our concluding chapter, the period of its death, sooner or later, certainly arrives.

In the trees which are youngest in their centre,—that is, the new additions to which are

made, not as in Exogens to the outside, but to the interior of the stem, and hence called Endogens, or growers from within,—Exogens being growers from without,—in Endogens then, it is easy to imagine that a limit to their growth may exist. Let us explain this matter in the following homely way. Suppose we had a hollow wooden cylinder before us, such as a barrel with the ends knocked out. Now, plainly, we might put as many large barrels as we chose over and outside the first, until we could only put no more because no one could make us a barrel large enough to fit over the last. But suppose we tried to cram the barrel full of rods or poles, we should succeed in getting a certain number in, but with all our efforts we could not get more, simply because the barrel would not stretch out larger. This circumstance then alone would limit us in our attempts to add to the size of the barrel; while it is manifest in the other case that there is no limit to its increase in size, but our inability to obtain a larger outside barrel. Had we the power to make barrels of any size, we might go on fitting one over another, until the great tun of Heidelberg, about which

we have all read so much, would be a mere pigmy to the huge cask which would fit over our accumulated barrels. If we were to make a section of all these barrels completely across, and look at the cut extremities, we should see, as is represented in the adjoining cut, the almost exact resemblance of the cross-cut stem of an Exogen; and doing the same with the barrel, into the interior of which we had thrust a number of hollow tubes or rods, we have something of the resemblance of an Endogen. The drawing will, we trust, make this very easy of comprehension.

DIAGRAM OF AN EXOGEN.

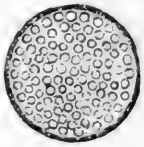


DIAGRAM OF AN ENDOGEN.

Even if we suppose the outer case of the Endogen to be in some measure able to expand, yet it is evident there would be a limit even to that, and beyond this it could not stretch. Yet while it is true theoretically that a limit to the life of Endogens must or may exist, it is also true that we are unable to fix it in the present state of our knowledge on this subject. Therefore our wisest course is to say, that

Exogens have the best chances of the longest life, and Endogens the worst; because in the former there is nothing to forbid their increase to any size whatever, and in the latter there is a decided limit set by their singular mode of growth, and the hard and resisting nature of the outer case of the stem.

Some astonishing instances of vegetable old age are on record.* John Evelyn, who used to be very much attached to trees, gardens, and country things in general, has mentioned several astonishing instances in his famous book called "Sylva." We will not quite vouch for the perfect accuracy of all that he relates, but it will perhaps be interesting to most of our readers to be made acquainted with some of these vegetable marvels. Thus he tells us that one of the Consuls and Governors of Lycia was in the habit of feasting his whole retinue in the hollow of a great Plane-tree. This enormous tree is said to have had a room in it of eighty feet in cir-

* For the method of ascertaining the age of trees, refer back to p. 103. It must be added, however, that too much stress must not be laid upon the number of rings as an index of the age of the tree in all instances.

cumference, which was adorned like one of the rooms in the Consul's palace, and enlivened with beautiful fountains of water: it had also stately seats and tables variously arranged in it. Evelyn further tells us, that there was, at some place in Gloucestershire, an oak-tree, which having become naturally hollow, was further excavated by human art and converted into a wainscoted room, which had windows with pleasant prospects on different sides of the tree, and was provided with comfortable seats within. How strange the sensation must have been to have taken tea with a party of friends inside a great living tree! From him also we learn, that in a time of war there was an oak in Westphalia which was resorted to by a band of warriors, who successfully garrisoned and defended it, using it as a castle and fort. With our improved modes of warfare, such a refuge would have been but of little avail.

Perhaps one of the most remarkable old trees is the celebrated Lime-tree at Neustadt, in the Duchy of Würtemburg. So far back as the year 1229—six hundred and twenty years ago, this Lime-tree was already a very great and

well-known tree, for, according to ancient documents, the new city was built after the destruction of the old one, which was called Helmbundt, "near the great Lime-tree." The city was consequently often called "Neustadt near the great Lime-tree!" One would have thought "the Lime-tree near Neustadt," a more correct expression, but such even then was the size of the tree, and so remarkable was it on that account, that the former designation, which was perhaps at first a *bon mot*, came to be used with complete propriety. It is mentioned nearly two hundred years later in an old poem which describes it as a great tree, the wide-spread branches of which were supported on *sixty-seven* pillars of stone, placed there by different persons. Two hundred years later still, the number of pillars which sustained it was eighty-two, and at the present time is upwards of one hundred! The tree is divided at the summit into two immense branches, one of which is upwards of one hundred feet in length; the other was injured in a storm in 1773.

In 1664 Evelyn tells us that the trunk of this huge tree measured nearly forty feet in circum-

ference. Calculations have been made of the probable age of this vegetable giant, and it seems pretty certain that it cannot be much younger than *eleven hundred and fifty years!* It appears that at various times, parts of this huge tree have suffered serious injury; as Evelyn informs us that it had been, before his time, much larger than it was even then, for many ruined pillars were visible which had once upheld its massive boughs.

At Schalouse in Switzerland there is another famous Lime-tree, "under which is a bower composed of its branches, capable of containing three hundred persons sitting at ease. It has also a fountain set about with many tables, formed only of the boughs, to which they ascend by steps, all kept so accurately, and so very thick, that the sun looks never into it."* It is related by the same author, that the Emperor Frederic III., gave once a magnificent repast upon a table which was a solid block of a tree, and was five-and-twenty feet in diameter, and of proportionate thickness.

The Chestnut-tree sometimes attains a great age and an enormous size. There are some large

* Evelyn "Discourse on Forest Trees."

specimens in England, but none of these will compare with the great Chestnut of Mount Etna, called the Chestnut of the Hundred Horses. This tree is described by a modern traveller, who surmounted many obstacles in order to get to see it. His first idea was that it was formed of five large trees grown into one; but upon some careful examination, he became satisfied that they had formerly been united into one solid stem, and on measuring the hollow within, he found it two hundred and four feet round! There has been much disputing about this great Chestnut; and some men of science are still inclined to believe that its size has been exaggerated, and that it is really three trees, and not a single trunk. It has been said of it that it contained as much timber as was necessary to build a palace!

In a valley near Constantinople an immense Plane-tree has been described, which renders the tale told of the Lycian Consul not so improbable as it might at first sight appear to be. This tree is described as being ninety feet high, and the circumference of the trunk as one hundred and fifteen feet. The trunk is hollow on a level

with the soil; and on measuring the dark wooden abyss within, it was found to be eighty feet in circumference. Supposing that the trunk had been solid, a table cut out of its trunk near the ground would have measured *at least* thirty-five feet across, and would have comfortably dined, allowing two feet to each person, upwards of fifty people. Altogether the tree covered a space of five hundred square feet. This tree may possibly be about two thousand years old!

The mournful Yew-tree is also famous for its great age. "Indeed," says Mr. Strutt in his work on the Forest Trees of Britain, "it can scarcely ever be said to die, new shoots perpetually springing out from the old and withered trunk." The Yew-trees at Fountains Abbey near Ripon, are at least seven hundred years old, probably several centuries older. For we read that when the monks were waiting the completion of the building of the abbey, they took shelter under these Yew-trees, and there remained protected only by their dense foliage from storm and rain until the monastery was completed, when they, probably with no great reluctance, quitted the shelter of the trees for

the warmer and more comfortable halls and refectory of the monastery. By counting up the concentric lines on the section of the trunk of the Yew-tree, it has been found that they increase about the twelfth of an inch a year in diameter. Therefore by our ascertaining simply the diameter of the trunk, we are able to tell pretty accurately the antiquity of the entire tree. It has been supposed that these Yews are about twelve hundred years old.

The Fortingal Yew, represented in the accompanying cut, is one of the largest and oldest trees in Scotland. It stands in the churchyard of Fortingal, a beautiful district lying in the heart of the Grampian mountains. This prodigious tree, as we are informed, was measured by the traveller Pennant, and found to be fifty-six feet and a half in circumference. It is now decayed down to the ground, and, as is shewn in the cut, there is sufficient space in its interior for the passage of a funeral procession, it being an old custom for the dead to be carried through the hollow, solemn-looking tree, in their passage to the resting-place where the rich and the poor rest together, and where the last remains of our

THE FORTINGAL YEW.

mortal bodies shall slumber until the morning of the Resurrection. This Yew-tree is supposed to be about two thousand six hundred years old.

The most ancient Yew in England is in the churchyard of the village of Braburn in Kent. In 1660, this venerable tree was fifty-eight feet nine inches in circumference. At present, if it still exists, it must be about three thousand years old!

As the voyager to Eastern India sails past Cape de Verd (literally, the Green Cape), he discovers, even while yet far from land, numerous great masses of vegetation which clothe the Cape in thick profusion, and from the verdant look they communicate to it, have in all probability suggested its title. These masses of green are enormous trees, known as *Adansonias* or *Baobab* trees. They were first discovered by a French traveller of the name of Adanson, and have been called after him. Truly they are of an enormous size! Adanson was astonished at their proportions, and still more so at what he thought was their probable age,—five thousand one hundred and fifty years. Some of the trunks had a diameter or cross-measurement of thirty feet, and a circumference of ninety. Other

travellers have found yet larger trees, and one is described as having a circumference of upwards of one hundred feet. The great branches are themselves like large trees, and spread out from the trunk with great regularity all round.

BAOBAB-TREE.

In the centre a branch rises up straight, and thus by the intermingling of innumerable boughs, the immense tree comes to wear something of the look of a colossal mushroom, or its top re-

sembles that of a hay-stack. The fruit of this tree is called Monkey Bread. It is said to be agreeably acid, and to form a pleasant article of dessert when mixed with a little sugar.

The Cedars of Lebanon have long been famous, and, as will be well remembered, are frequently mentioned in Scripture. Some of these trees on the tops of the oldest mountains, had attained a very great age, and were examined by the old traveller Maundrell. The circumference of one measured by him was between thirty and forty feet, and its great branches were each of them as large as an ordinary sized tree. It was supposed they were from one to two thousand years old; but it is more probable that they were not much more than eight hundred years. Since he visited them all the ancient trees have been cut down, and now Mount Lebanon can only boast of some younger trees of the same description.

We are told by Evelyn that St. Jerome actually saw in his day the Sycamore-tree up which Zaccheus climbed to catch a glimpse of our Saviour as he passed by. As St. Jerome lived in the fourth century, the tree, if his statement is cor-

rect, must have been then about four hundred years old. But we must warn our young readers that these legends are not always—indeed, not often—correct, and that there is, therefore, some doubt whether the Sycamore-tree in question *was* that same tree up which Zaccheus climbed because he was short of stature.

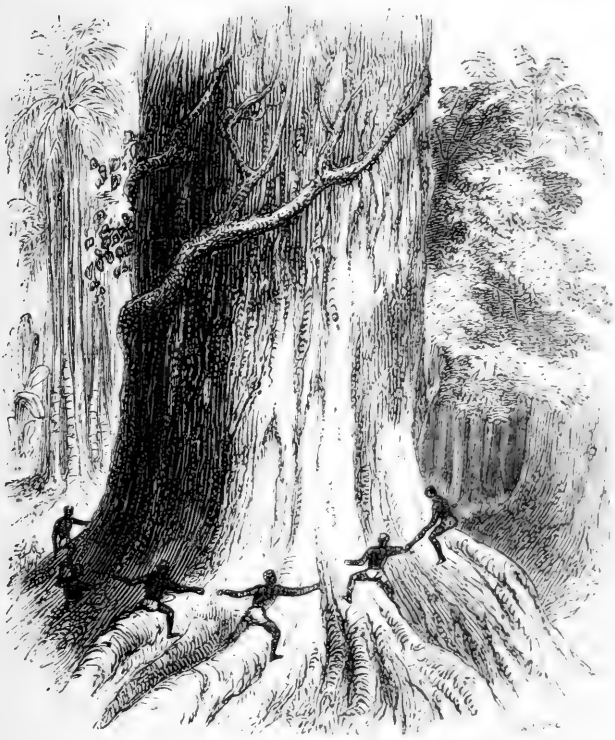
A French newspaper, some years ago, contained the account of the felling of an old Oak in the forest of Ardennes. The woodsman who cut it down was surprised to find in its interior some remains of sacrificial vessels, and some ancient medals or coins. The date of these coins was upwards of two hundred and seventy years previous to the foundation of the City of Rome. It was calculated from these data, that the tree could not be less than three thousand six hundred years old. M. de Candolle questions the accuracy of this calculation, and says that the utmost we can assume is that the coins were probably hid in the trunk at the invasion of the Goths, when coins were often largely secreted; and this would make this venerable oak at least fifteen or sixteen hundred years old.

The Cypress likewise attains a great age. This

tree is very abundant, and reaches its utmost size in America, particularly in Mexico. In the Magazine of Natural History, an account is given of one which is known by the name of the Cypress of Montezuma, because it was, at the time when that prince ascended the throne, in full vigour and luxuriance of growth. Its circumference at the bottom of the trunk is forty-one feet, and it still exists flourishing and venerated in its old age. The Baron Humboldt speaks of one of the same species, which is one hundred and eighteen feet in circumference; but it seemed to him that this monstrous trunk was composed of three trees, which had grown into one. This tree is still flourishing near Oaxaca, surrounded by five or six others of great size. The large tree is one hundred feet high. It is related that the army of Cortes once reclined under its shadow. It is highly venerated by the superstitious natives of Mexico. This Cypress has been supposed to be at least four thousand years old.

The celebrated traveller Von Martius, in one of his beautiful botanical works, has a passage which is so striking that we shall transfer it to these pages. The learned traveller is speaking

of the great Locust-trees which exist in the old woods of Brazil. "The place where these pro-



LOCUST-TREES OF BRAZIL.

digious trees were found, appeared to me as if it were the portals of a magnificent temple, not

constructed by the hands of man, but by the Deity himself, as if to awe the mind of the spectator with a holy dread of His own presence. Never before had I beheld such enormous trunks, —they looked more like living rocks than trees; for it was only on the pinnacle of their bare and naked bark that foliage could be discovered, and that at such a distance from the eye that the forms of the leaves could not be made out. Fifteen Indians with outstretched arms could only just embrace one of them. At the bottom they were eighty-four feet in circumference, and sixty feet where the boles became cylindrical." By counting the concentric rings of such parts as were accessible, he arrived at the conclusion that they were of the age of Homer, and three hundred and thirty-two years old in the days of Pythagoras. One of his estimates reduced their age to two thousand and fifty-two years, while another carried it up to four thousand one hundred and four; from which he argues that the trees cannot but date far beyond the time of our Saviour. Their colossal appearance is well shewn in the cut, a small portion of the lower part of the trunk only being represented.

The famous dragon-tree of Orotava, a sea-port town in the Isle of Teneriffe, has been repeatedly mentioned by travellers, on account of its immense age and size. It is thus described by Humboldt. "This gigantic tree is now in the garden of a M. Franchi, in the little town of Orotava, one of the most delicious spots in the civilized world. In June 1799, when we ascended the peak of Teneriffe, we found this enormous tree then possessing a circumference of forty-five feet a little above the root. Tradition relates that this dragon-tree was worshipped by the Guanches the original inhabitants of the island; and that in 1402, it was as large and as hollow as when we saw it. When we call to mind that the dragon-tree is of a very slow growth, we may readily conceive that this Orotava giant is extremely old. Without doubt it is, next to the Baobab-tree, one of the oldest inhabitants of our planet." From time to time this great tree has seriously suffered from the effects of hurricanes. In July 1819, a large portion of its top was blown down. A traveller who visited it in 1837, states that it was still in existence, growing in a neglected cabbage-garden, uncon-

nected with houses. M. Berthelot remarks that on comparing the young dragon-trees which he had seen at Orotava with the giant tree in M. Franchi's garden, the calculations he had made upon the probable age of the latter have more than once outstripped his most elevated imaginations.

It may perhaps serve to shew in a more striking light the wonderful ages to which different trees occasionally attain, if we place them in the form of a table. Thus after careful examination it would appear, that the following trees have attained the enormous ages appended to each of them.

	YEARS.
Cedar-trees	800
Oaks	from 800 to 1600
Lime-trees	1100
Plane-trees	2000
Yews	from 1200 to 3000
Baobabs	5000
Courbarils	from 2000 to 4000
Cypresses	4000

What a subject for reflection is here! What was the age of the oldest man that ever lived, compared to that of these long-lived offspring of

the earth! Think of the old Yew-tree in Braburn churchyard; what a life would the life of that tree be could it be written! But rolling years, although they each left the print of their footsteps in the concentric ring-marks on the inner stem, have left no other trace of their events; and all that can be learned from the contemplation of them is but the number of the ages which have glided by, and left the Yew-tree yet alive. Yet what cannot be learned directly from the tree itself, we may be able to supply from other sources of knowledge.

Eleven hundred and fifty years before the birth of Our Lord, the Braburn Yew-tree was a sapling just rising from the soil of savage England. The sun that shone upon its young branches, shone likewise, but with more fervent heat, upon the head of the aged Eli and the child Samuel, ministering before the Lord in the tabernacle at Shiloh. It lived and grew, and began to lift its head and look out upon the land; but no village clustering round the ivied church was there, no fields golden with corn or green with grass, nor any bared and naked by the plough; nothing but a tangled wilderness where the wild hart had

its lair,—a wilderness the solitude of which was broken by no voice of man, but which was the undisturbed domain of birds and beasts and reptiles, of which nothing but the dead bones now are to be found. A century later saw, as it is said, the vessels of a Trojan warrior touch the desolate shores of England, and establish the first colony in our island; it also saw the good King David reigning over the many thousands of Israel and Judah; and it saw the Yew-tree, then arrived at tall and fair proportions, holding up a head that was to brave the contests of a score of centuries, boldly but modestly amongst the trees in its vicinity. King David was gathered to his fathers; the foreign colonists were succeeded by their children of many generations downwards; but the Yew-tree grew stronger and stronger amid the decay of every other earthly thing.

The great stream of the river Time flowed on, sweeping down year by year its millions of the human race, while fresh millions followed in their place. Rome, the "mistress of the world," as she has been called, received her first stone, grew great and powerful, and conquered distant na-

tions. The long line of Jewish kings disappeared in all but the name. The voice of the Old Testament prophets ceased, England grew populous and cultivated in parts, Julius Cesar invaded our shores, and, after a stubborn resistance, put Britain under the Roman yoke. And the Braburn Yew-tree continued to grow stronger and stronger amid the change of earthly things, and of the destinies of its native land.

Eleven hundred and fifty years were written in unerring characters upon the heart-wood of the Braburn Yew. Yet it shewed no symptoms of decay; nay, rather it seemed as if the past time had only heaped upon it additional strength, vigour, and size. Men had long regarded it as an object of extreme antiquity, little dreaming that but a third of its life was yet spent, and that its evergreen branches should wave over the last resting-places of their children of the fortieth generation!

There was the silence and darkness of night brooding over England. The stars glimmered with their diamond-light in the deep, unfathomable, arched heavens. The wind was asleep, the earth too slept, and in his rude uncomfortable

hut the half-savage Britain slept also. In the forest, now and then a leaf left by Autumn on the topmost bough, snapped off and tumbled to the ground. And as the cold of night increased, a long-rotten branch broke also, and fell rustling down. Beside these, and the occasional whoop of the night-owl, all was still; and the great Yew-tree, with its countless leaflets, seemed as though itself were listening. What a scene was then taking place in the far distant East! There were in that country shepherds abiding in the field keeping watch over their flock by night. "And, lo, the angel of the Lord came upon them, and the glory of the Lord shone round about them.—And the angel said unto them,—Unto you is born this day, in the city of David a Saviour, which is Christ the Lord.—And suddenly there was with the angel a multitude of the heavenly host praising God, and saying, Glory to God in the Highest, and on earth peace, good will toward men." Yes! the Braburn Yew-tree lived at the moment when the whispering of a "Saviour born" went round the earth, and filled the heaven with praise.

It was alive, and may have felt the earthquake, and beheld the darkened sun, when later on in time the Saviour bled and died upon the accursed tree. The far and wide proclamation of the Gospel; the rise and fall of empires, states, and kingdoms; the annihilation of nations, cities and armies; the rolling away of the clouds of ignorance, heathenism, and superstition; the era of the dawn of light upon our country, the memorable Reformation and its companion blessings, with all the long roll of events unfolded in the providence of God, down even to our own age, when the snorting sound of the locomotive and the rushing to and fro of the chariots, sweep in sharp vibrations through the aged boughs;—all these, and more than we can tell beside, had a place in the life-time of this patriarch Yew-tree. Would that the Braburn Yew-tree had a tongue, and that, resting under its venerable branches, we could hear it unfold in order the mighty and momentous things that have taken place in the three thousand years of its existence!

But it is time well returned to our more immediate subject. The famous Banyan-tree

deserves mention on account of its great age. A celebrated one is flourishing still in the island of Nerbuddah, and is called by the name of the *Cubbeer Burr*. It is supposed to be about three thousand years old: it possesses three hundred and fifty large trunks, and three thousand smaller ones; each of its branches is continually adding to this number by sending down roots which subsequently take root in the soil. The tree is in fact more like a forest than a tree, and is the dwelling-place of thousands of birds, insects and small animals. Its entire circumference is about two thousand feet; but from the fact just mentioned, namely, the continual putting forth of new trunks, we are not justified in considering it as a single tree, but rather as a union of many separate ones.

Before quitting the subject of the age and size of trees, a curious fact connected therewith may be mentioned. The Americans, who are fond of anything striking and uncommon, published an account in one of their papers, some years since, of a singular exhibition then being shewn at the American Museum at New

York. It appears that a Sycamore-tree of enormous size had been cut down, and a large portion was cut off the bottom of its trunk, hollowed out artificially, and turned into a drawing-room! We presume the trunk was placed horizontally, and the room was thus formed in the length of the trunk. It was splendidly furnished inside, and was ornamented with a profusion of articles of elegance and utility. Magnificent mirrors adorned its sides, and carpet, sofa, and chairs were arranged in it for the accommodation of visitors, who, if they were musical, might enjoy the additional luxury of a fine piano! Beautiful pictures were hung upon the wooden walls, and those little knick-knacks which ladies delight to scatter about their boudoirs, were appropriately placed in this strange apartment. It was stated that it would accommodate comfortably forty or fifty persons. The same papers contained an account of another Sycamore trunk, which was fitted up and in constant use as a shop! Both these must have been splendid trees, and it almost seems a pity to have destroyed them simply to turn them into great baby-houses.

It may be asked, ere we conclude our chapter, whether the trees which attain to this extreme old age are capable of still bringing forth flowers and fruit? Unquestionably they are. The return of the fruit-bearing season to the rest of the vegetable world, is not less a return of vigour to them also, although hundreds, or even thousands, of the year-waves of time have swept over them. The Apple-tree of fifty years of age, if it has not exhausted the soil, bears its fortieth load, and may think, so to speak, proudly of itself; but the mighty Oak, whose bold figure heads our chapter, bears its fruit-load too,—and that, not for the fortieth, but five hundredth time. The mere circumstance of their great age does not necessarily preclude the possibility of their "still bringing forth fruit." But if the soil in which these old trees grow has been drained of those ingredients which the tree requires for the production of fruit, then of course the old age of the tree will be barren and unproductive.

In proof of this, the following facts may be brought forward. There are some Olive-trees at Jerusalem, which still bear fruit, of whose

real age we are able to ascertain, according to M. de Chateaubriand, a very satisfactory proof. When Palestine was overrun by the Turks, in the year 1075, the Olive-trees then standing were to pay a tax of a small portion of their produce to the conquerors, while all that should be afterwards planted were to forfeit half their fruit to the Sultan. Now, the Olive-trees in question only pay the small tax, and it is therefore highly probable that they existed when the Turks entered Palestine, and are therefore eight hundred years old, or nearly that. Hence for eight hundred years these trees have yielded fruit for the service of man. Could each year's produce be ascertained, how many tons of Olives would the entire sum for this period shew! Again, when Baron Humboldt visited the giant Dragon-tree of Orotava, he writes of it, "It still bears every year both fruit and leaves. Its aspect feelingly recals to my mind that eternal youth of nature which is an inexhaustible source of motion and of life." Yet this tree cannot be much under two thousand years old, and is probably older considerably even than that.

Another year has gone by and left its seal upon

the tree's stem, and again the approach of Winter warns the aged trunk to make ready for the airy conflicts of the season. The leaves are dropped, the young buds are wrapped up warm and close in their varnished coatings, and the mighty king of the forest stands stripped for the battle, awaiting the first onset of the tempestuous time. It can look back, perchance, on the victories of half a millenium, and has, as we may think, but little cause to dread the conflicts yet to come. How long it may yet survive we dare not say. The eye that rests upon these pages may be dim with age, and the hand that writes crumbled to dust; yet the old tree may live and flourish, and year by year renew its strength. It seems to set Time and Mortality at defiance. Let us wait and see.

P

THE DEATH OF THE TREE.

CHAPTER V.

THE DEATH OF THE TREE

The aged tree is dead! Many Winters have passed over it, many storms battled with it, the lightning struck it, time, air, rain, insects, worms, and the plants called parasites, preyed upon it; it could stand no longer. A howling north-wester had been ploughing up the face of the country all the day, carrying on its swift invisible wings broken branches, withered leaves, portions of haystacks, and the wreck of such like things. The tree trembled and groaned in its strong embrace; the sun went down, but the battle continued half through the moonless night. Limb after limb was snapped off with a crash like the discharge of a fowling-piece. It was near midnight,—the storm rose higher and higher: looking out, nothing was to be seen but the indistinct forms of mighty trees doing obeisance to the

over-conquering wind; looking to the tree, its great form was as upright as ever, but through the dim half-light, half-obscurity, could be seen its thousand branches shaken with the mighty wrestling, and every now and then a strong convulsion seized its huge limbs. What a night was that! How the air reeled and whirled in its course, carrying all before it! What a fitful roar every now and then shook hill and dale, as it came in fiercer gusts sweeping over the frightened country. Again and again the wind and the tree joined issue, and though with occasional damage, the tree came off victor. Midnight came, a heap of dark and heavy clouds darkened the air, and the storm was at its height. The roar of the tempest was now awful beyond description. A fiercer gust than any came up and laid its violent grasp upon a tree; for a minute the tree stood—in a minute more, a sound, like that of distant thunder, swept across the fields:—the great tree was blown down, all but the ruined stump on yonder Frontispiece. Such was the death of a tree with which the contending elements for more than five hundred years had warred in vain.

The death of this tree, and of many others, was brought about in the following manner. Many years ago in somewhat such a night as that of its death, the tree, then strong and solid, lost a great limb by the violence of the storm. Succeeding storms injured it in various ways, and thus tore open its tissues, exposing the unprotected stump to the destroying influence of air and moisture. Now, such is the powerful chemical influence of these two, apparently so innocuous and feeble agents, that it becomes impossible for wood to be long exposed to their attacks without rotting. The oxygen gas that forms part of the air, enters into union with the fibres of the wood, together with the moisture of the falling shower; and in process of time they render it quite soft, brown in colour, and very easily broken in texture. In the language intelligible to chemists it is converted into *Humus;* that is into brown mould, much like that which forms part of our gardens. This may be easily confirmed, if any of our readers will take the trouble to compare what they will find in the hollow trunk of some wayside tree with the mould of a flower-bed; only it is always to be remembered

that the latter contains, besides decayed wood, a large quantity of various earthy and mineral substances.

Unfortunately for the tree, this decay does not stop at the broken stump; it extends further and deeper into the trunk. The more limbs have been broken off, the more rapidly will the decay go on. Gradually the centre of the trunk becomes attacked, as being the oldest and least able to resist the progress of the disease. It becomes more and more eaten away; at first a wren built her nest in it, but by and by the hollow grew too large for her, and she shifted her quarters elsewhere. School-boys then found it out, and amused themselves with casting heaps of stones into it. Later on, the hollow became the favourite hiding-place of children; and after this the shepherd took his mid-day sleep therein. So it went on, becoming yearly, but very slowly, more and more capacious, and threatening the life of the tree at every storm, in proportion as it weakened and consumed away the strength and substance of the wooden walls. The Frontispiece shews to what an extent this hollow ultimately reached; for we read of the venerable tree whose portrait

is there represented, that "In the year 1724, a road-way was cut through its trunk, higher than the entrance to Westminster Abbey, and sufficiently capacious to permit a carriage and four horses to pass through it. A print of it was published at that time, in which it scarcely varies from its present appearance, excepting that the artist has sought to heighten the effect by choosing the moment when one of the old-fashioned equipages of the day, and its four long-tailed appendages, were passing through the cavity."* When this decay has gone thus far, the powerful pressure of the wind is sure ultimately to lay the crown of the tree level with the earth, and very frequently to prostrate the entire trunk.

What a mournful picture of decay and death is presented to us by the tree whose history we have been seeking to unfold for these many pages past. Where is its young luxuriance, its mature vigour, its old age green and fresh, now? Spring may invite out, as before, leaves and blossoms, but they come no more obedient to its call to adorn the naked trunk. The bright and play-

* Strutt. Sylva Britannica.

ful ray of the Summer's sun may warm the old timber, and dart here and there into its huge recesses; but there is now no sap to change, and no fruit to ripen. Autumn comes and finds her old companion for half a thousand years struck dead at last, and no longer sensible to the sweet influences of the season. Winter rejoices over the hoary monarch, terrible, gaunt, and majestic even in death; for Winter laid him low, and sends his fierce messengers, the winds, to buffet and molest the rugged remnant of the dead trunk, and then, as though with a trace of pity, buries the sad monument of its own ruthlessness in a mountain of snow.

Is there an "appointed time" for the duration of vegetable life? Job tells us, Chap. xiv. 7. "There is hope of a tree, if it be cut down, that it will sprout again, and that the tender branch thereof will not cease. Though the root thereof wax old in the earth, and the stock thereof die in the ground; yet through the scent of water it will bud, and bring forth boughs like a plant. But man dieth, and wasteth away; yea, man giveth up the ghost, and where is he?" But this sentence, in all probability, is only intended to apply

to those plants which die down to the ground every year, and put up a new stem in the succeeding Spring:—these plants are called Perennials. But not so with the tree,—as it falls, so it must lie. Once dead, no scent of water nor animating influence of any kind from without will cause it again to put forth the tender branch. It seems probable that there is an "appointed time" for plants as well as for animals; a time, at the close of which, even allowing that they had escaped every accident and disease, they must pass from the stage of native existence, and return to their original dust. It must be added, however, that all botanists do not think thus. The celebrated De Candolle, whom we have so often quoted, believes that plants do not die of old age, but in all cases perish either by means of some fatal accident or other hindrance to their growth. But others, such as M. Mirbel, of equal authority and talent, believe that independently of casualties or disease, plants of all kinds are doomed to die of old age.

Just as in the animal world there are insects which are born and perish in a day, so in the vegetable kingdom there are plants which are not

only born and dead in a day, but in the course of a few hours. Several of the fungous plants, such as the delicate "moulds" which so soon appear on our food if it is allowed to become bad, only exist as individual plants a few hours.

There is one of them in particular, called the *Achlya Prolifera*, which completes its appointed time in an hour or two. This little plant can only be seen by means of the microscope, and has been described as consisting of transparent threads of extreme fineness, packed together as closely as the pile of velvet; at the top of each little thread is a minute ball of the shape of a pear, so minute that twelve hundred would lie in the length of this line, that is, an inch.———— These little balls are hollow, and contain a number of very small granules, which are constantly moving about, until at length the cell or ball bursts and lets them out, when they become plants themselves. Now, if we regarded each of these little threads as a separate plant, we should find, that in a period of not longer than three or four hours, the little plant would be born, become the parent of a multitude of others, and perish. It is an interesting fact in

connexion with this plant, to know that it often causes the death of gold-fish. Being capable of growing under water, it attacks the poor fish, spreads itself over its body, covering it with a whitish slime, and sometimes in less than the course of a day destroys the fish even if it had been apparently quite healthy previously. Should the fish be seen thus covered, the reader will know the nature of its disease, by which it is, as it were, caught in a vegetable net; but we are sorry to have to add that we are not acquainted with any remedy that can be successfully adopted to get rid of the disease.

The plants next in point of age to these are perhaps those called Annuals. These are sown in the Spring, presently spring up, grow luxuriantly for a few months, and as Winter comes, wither and die. The great Sunflower, which reaches such a height and vigour of growth, and turns up its golden features to the sky for many a long Summer day, perishes as the night-frosts come on, its leaves and stems turn brown, and the next breeze humbles it to the earth. After these come the Biennials; in these the flower-stem is not developed, nor the flower,

nor seed formed during the first year; but all this takes place in the second year,—after which the plant perishes. Then come Perennials, which complete their round of developement in the year, die down in Winter, and rise again with new glory and vigour in the following Spring. "In most *woody* plants," says M. Mirbel, "death does not occur until fructification has recurred for a greater or less number of years; some of the monocotyledonous (Endogenous) plants however, such as the Sago-tree and Umbrella-tree, with immense fan-formed leaves of eight or ten yards in length, only bear fruit once, and then die."

"In proportion," continues the same author, "as a tree increases in size, the vessels of its woody layers become obstructed, and the sap circulates with less freedom. Hence, absorption and secretion decrease after youth, in proportion as the bulk of the tree is enlarged; the bark becomes less vigorous; the buds and roots become fewer and feebler; the branches wither; the stem decays at the head; water settles in the injured parts; and the wood moulders away."

There are a number of causes which may hasten the death of plants, irrespective of the

effects of old age. As they are unable to leave the position in which they are found in the soil, their only means of obtaining fresh nourishment being the elongation of their roots, it is very evident when they have consumed all the food of an appropriate kind that they can find, they must become gradually more and more feeble, and will at last die slowly of starvation. It is true, the roots are ever on the search for fresh food; but then there may be certain difficulties in the soil itself which they cannot overcome. Let us quote for example the instance given us by our Saviour in the parable of the sower, the seed sown on a rock, the plant quickly springs up; but because there is not sufficient earth and room for the roots, it soon withers away and dies. So under the surface of the ground there may be various obstacles which render it impossible for the roots to proceed beyond a certain distance; and the inevitable consequence to the tree will be, first, that it becomes flowerless and fruitless, and finally that it perishes altogether.

In addition to these circumstances, a number of causes acting as it is said purely from without,

that is, not dependent on changes taking place in the tissues of plants, hasten their decay and premature close of life. Thus a plant may be growing where it cannot get enough air, or enough light, or it may be consumed with thirst; or there may be some substances actually deadly to it in the soil; or other plants, such as weeds, may crowd around it, and suffocate it by their close-entangled roots. The wild beast may trample it down, the tempest may uproot it, the severity of the Winter may freeze it through, the heat of Summer may scorch it, and finally, man himself, whether in the character of the woodman, reaper, or gardener, may put an end to its existence for the accommodation of his own purposes, or for the gratification of his tastes.

Beside all these messengers of death to the vegetable kingdom, it is a very interesting and singular fact that plants are subject, just as man and animals, to the attacks of disease. To us who have suffered so severely in consequence of the recent visitation of Providence,—the potato disease,—this subject is peculiarly interesting; but it is impossible to spare room to enter into it fully in these pages. There is a disease liable

to attack the plants we keep in our drawing-rooms, particularly if our houses are situated in dark and smoke-obscured quarters of the city, which is simply caused by the absence of sufficient light; this is called *etiolation*. Every one must have noticed the difference in the look of in-door and out-of-door plants; it is as great (and curious to say it depends upon the same cause) as between a Londoner and a ruddy ploughman fresh from the cart-tail. We may refer back the reader to page 69, for the purpose of refreshing his recollection on the influences of light. This is the sole cause of this malady,—the plant has not enough light; it consequently becomes of a sickly, pale-yellow colour, grows weak and straggling, and ultimately dies, pining away for the absent sun-light.

We are perhaps right when we say, that the art of gardening lies in a great measure in bringing up plants in perfect health. Just as the little squalid children of our streets are sickly and pale, and prone to many diseases that never attack children placed by the Providence of God in happier circumstances; so plants that are neglected by their owners, fed with improper food,

either too much or too little, or not of the right kind, cannot but grow up feeble and sickly things, scarcely able to bear the exhaustive effort of flowering, and soon dying away, perhaps to the great perplexity of the careless or ignorant possessor of them. It is quite certain that plants may die of the *dropsy* if they are too much watered. Succulent plants in particular will sometimes suddenly become diseased in consequence of the mistaken kindness of too much and too frequent watering.

There is a curious disease of trees called Honey-dew,* which is both a pretty and expressive name. It consists in the leaves of the tree pouring out clear thick, sweet drops of honey-like liquid. For a long time it was thought to be the effect of little insects piercing the leaves; but this explanation is now generally considered incorrect. A gentleman in Germany possessed a plant growing in his house, which exuded on the surface of its leaves in each September large colourless drops, which formed regular crystals of *sugar-candy* upon drying. It has also been observed,

* It is right to mention that the Honey-dew has been attributed to other causes, such as the exudation from the bodies of insects.

during very hot and dry summers, that the leaves of Lime-trees have become covered with a thick and sweet liquid, and in such quantity that for several hours of the day it ran off the trees like drops of rain. Many pounds might in fact have been collected from one tree; the juice contained sugar. We can scarcely assert, however, that these diseases are such as are calculated to shorten the life of the plant, excepting so far as they shew that it is an unhealthy condition.

The terrible Potato-Disease has been variously accounted for, but still remains inexplicable. Some singular circumstances have been mentioned, as to its appearing in certain fields of particular districts of the country, very shortly after the appearance of thick, peculiar clouds of fog. From which it has been supposed that the fog must have contained some unusually destructive ingredient. How far this conjecture is sufficient to explain all the phenomena attendant on this visitation, we are not here able to say. Others believed that it was produced by the attacks of insects; which certainly was quite incorrect. Many chemists believed it to be owing to bad agricultural management; and others at-

tributed it to changes in the electricity of the air. The poor called it the potato-cholera; perhaps

ORCHIDS GROWING ON A DEAD TRUNK.

only because the progress of the disease in the vegetable was almost as rapid as the disease of the same name in the human subject.

Plants are subject to the attacks of other plants which grow upon and even within them. Some of these actually live by drawing away the sap of the plants or trees on which they luxuriate; but others, like the beautiful orchids represented growing on the branches of that dead tree in the cut, simply rest upon the tree and do not derive anything from it, living upon the air, and only putting forth a sufficiency of small roots on the branch on which they repose, to secure them to it, while they send out their large roots into the air around. The mistletoe, on the other hand, is a true parasite,—that is, really and truly lives by sucking the juices of the tree on which it grows.

These "parasites" are of a large size, and their deleterious influence on vegetable life is exercised only on one or two individuals in a hedge-row or field. The most alarmingly destructive are of a very minute size, and in fact only to be seen by the help of the microscope; and these may sometimes cause terror to an entire nation by the ravages they commit among plants upon which we depend for our food. The blights of wheat are, several of them, of a vegetable nature, consist-

ing of very minute fungous plants. The disease called by the farmers the "Rust" in wheat is of this nature. It attacks the corn-fields in Spring, particularly in wet seasons; and soon causes the heart of the agriculturist to tremble for his crops, as with sorrow he contemplates their drooping, yellow, sickly aspect. While the wet weather lasts, the fungus grows rapidly, the corn-plant suffering in proportion; but if the rain is stayed, if the sun again sheds his warm influence on the fields, and the moisture thus becomes dispersed, the fungus soon withers away, and the drooping blades stand fresh, green, and erect, as though they had never been the victims of disease. Another is called the wheat-mildew, and is also most liable to attack the corn in moist seasons. The little seeds, or more properly speaking "sporules," from which these fungi are developed, are infinite in number, and of extreme minuteness in size. They are supposed to rise like thin smoke into the air by evaporation, and are then scattered about in every direction by the winds. An author who has paid much attention to these matters, has calculated that in one plant there were at least ten millions of these

fungi. This disease is at times very destructive.

A host of insects also attack plants and produce disease more or less injurious to them. Every one who has had a rose-tree under his care, must have noticed occasionally a general unhealthiness of appearance steal over the plant, many of the leaves drooping, and the branches ceasing to grow. On turning up the leaves, there will generally be found a thick crowd of green insects which are feeding with all their might upon the pleasant sap of the young shoots. These are called Aphides, and if not checked they will ultimately destroy the plant. The number of the different species attacking vegetables is altogether astonishing; and we are filled with wonder to find, that we really suffer from their attacks in our gardens, fields, and orchards, as little as we do, when we remember how easily their numbers might be multiplied, and how awful have their devastations been on special occasions. More than once have the desolations produced by a caterpillar humbled great nations, and brought crowds into the house of God to entreat Him to remove the plague from the land, and this

even in England and France. In the East it is of course well known to the reader that the plague of locusts both has been and is the most terrible of the visitations of Divine Providence, in consequence of their eating up every green thing, and leaving the country behind them with the appearance as if a consuming fire had scorched up every plant, shrub, and tree. By their attacks on Oak-trees, insects produce the little excrescences so useful and well known as oak-galls. This disease, however, is not fatal to the trees.

These few remarks upon the diseases of the vegetable world, though mere outlines of this interesting subject, will help to shew that plants are not less liable to the evidences of mortality than men and animals. However fair they may bid to endure, not for an age but for ever, disease marks them as well as us for its own, and in some one out of a thousand ways death comes at last, even to trees which have braved out every opposition for more than a thousand years.

After death many important changes take place, to which it is necessary to allude before con-

cluding the history of the Tree. When an animal dies, a process of putrefaction begins, which terminates in reducing the entire frame to water, earth, and gas. "Dust thou art," said the voice of the Lord God in the garden of Eden, "and unto dust shalt thou return." Such likewise is the fate of every created thing in the vegetable world, from the grass that is cut down and withereth, to the tallest and greatest tree of the forest. To dust must all return. It is true that man cuts down wood, and prepares it for his own purposes, and by incorporating it into buildings, helps to preserve it from destruction for a certain time. This only defers the time of its being reduced to dust, and unless the wood is chemically prepared, dust it will still certainly in the end become. By steeping the timber in some chemical solutions, such as solution of corrosive sublimate, which is the plan adopted by Mr. Kyan, in his celebrated method of preserving wood from decay, it is possible to keep it for a very long time without its rotting; how long, time must prove.

The disease called Dry Rot is that which is most prone to attack the timber of our dwellings.

The wood becomes brittle, and crumbles into a yellow powder. In damp situations, this change takes place very rapidly, producing in the course of a few years the most alarming injury to entire buildings and ships. It is not clear what the exact chemical nature of this change is. It seems to be connected with the influence of little fungous plants which infest timber; but it certainly often takes place without fungi being present. Another form in which the decay of woody fibre takes place is very important for us to consider; it takes place under water.

Has the reader never plunged his hand beneath the waters of the brook in search of "bait," and drawn forth a mass of rotting sticks and chips, already turning soft and brown under the influence of this form of decay? If he has, he may be informed that he has seen the first step in the process of the formation of Coal! Were we to be asked What *is* coal? it would probably be the best answer to describe it as wood which has rotted under water and has afterwards been subjected to great pressure from heaps of mud overlying it, and which has in consequence of these two things, rotting and pressure, become

consolidated into the black and stony substance —coal. There can scarcely be any question that all the great beds of coal forming the various coal-fields, as they are called in our own and other lands, were once living forms of vegetation. The remains of leaves, seeds, roots, and stems have been found in coal, thus appearing to shew without a doubt that this substance was once in the very different shape of perhaps stately trees, elegant shrubs, or even fruit and flowers. What an astonishing change of circumstances, to think that the matter which long ago basked in sunlight, and possibly filled the air with fragrant odours, is now deep buried under the surface of the earth, whence it must be dug in darkness and danger; and owing in a great measure to our ignorance about the philosophy of the fire-grate, instead of diffusing perfume, emits the most disagreeable odours, polluting the atmosphere it once helped to purify! Most enormous is the mass of wood thus rotted and turned into coal, as may be imagined from the following facts. The annual consumption of coal in Europe amounts to more than 33,875,000 tons; and careful calculations shew that even if the consumption of coal

should increase, the store laid up by Divine Providence for the use of man will certainly last for five hundred years longer! Such a store corresponds to about 12,025,000,000 tons of carbon.* Amazing thought—all this derived from the air! The nature of the chemical changes by which wood becomes coal would be far too intricate for us to study in this little work. We must therefore remain for the present satisfied with the bare statement of this apparently unquestionable truth, that under appropriate circumstances a series of decompositions take place in woody fibre, which end in the production of coal.

The remaining process of decay is the most common of all. By means of it, all existing forms of vegetation, when they die, are reduced to dust, or more properly, to mould. All parts of a tree become by this process equally resolved into the same substance. It only wants time for the solid stem to take the same condition and character, in every respect, as the delicately tissued leaf, or the tender blade of grass. The chemical forces attack each alike, the only difference being, that the soft and juicy

* Dr. Schleiden.

nature of the one part more easily and quickly yields to them, than the firmer and drier nature of the woody tissues permits the other to do.

This change has been already described in a previous page, in alluding to the cause of the decay in the trunk of the tree. It is, as has been before said, the wind and the rain which produce the crumbling down of the firmest structures of the vegetable world. These simple and, in our eyes, weak and inefficient agencies, are the Divinely appointed means whereby the dead portions of plants, or the dead trunks of entire trees, are, without fail, to be restored in a common but altered form to the bosom of the earth; nor can any vegetable structures long resist their operations. By their means the materials long since taken from the soil, in the shape of alkalis, salts, and mineral ingredients, are all safely restored again. During the period of its existence the plant may indeed accumulate within itself a very large portion of these substances, and in proportion impoverish the soil in which it grows. If these substances were to be no more restored to the soil again, it would by and by become

totally unfit for cultivation, or at least for the cultivation of the same plant. Man, for instance, when he reaps the corn-field, carries away a large portion of saline and other fertilizing substances in the wheat, which he stores in his garner. But he does not next year sow the same crop in the same field, because he knows he has in a measure exhausted it, and must wait until, by the chemical influence of the air upon the soil, fresh saline and mineral substances are set free. Now in order to give back a portion of such matters again to the field, what does man do? Precisely what Nature does, as will be easily perceived from the following consideration. The straw of the wheat is exposed to moisture and air in the stable; it begins to rot, is then thrown on the dunghill, and is in course of time, when quite rotted and brown —now being termed manure—again spread over the fields. Thus the various substances it contained are in due time restored to the soil again, with which they become mingled by means of ploughing or harrowing. Such, too, is Nature's plan. In Autumn, the now useless leaves are strewed on the earth, and in Winter a large number of plants die. So soon as this takes

place, the same process of rotting goes forward; and so, in the course of the next year, all the saline and mineral substances of these leaves and plants become mingled with, and restored to, the soil.

The process of rotting, then, in the dead parts of plants is one of great importance. It may indeed be far from agreeable to our feelings to watch the golden straw become converted into the filthy manure, and we may perhaps feel much annoyed at the damage done by this process to the timbers we had stored up for our own use. But in the changes here proceeding, we ought to mark, with feelings of wonder and of love, the working out of a great and beautiful design in creation; one, in fact, without the operation of which we should become subject to far greater inconveniences than those just alluded to; or indeed, to any others that might arise out of this principle of decay. The great dramatic poet wrote that we might

> "Find tongues in trees, books in the running brooks,
> Sermons in stones, and good in every thing."

And is it not so when we can point to the steaming dung-heap in proof of the wisdom and foresight of the Great Creator and Lawgiver of the Universe?

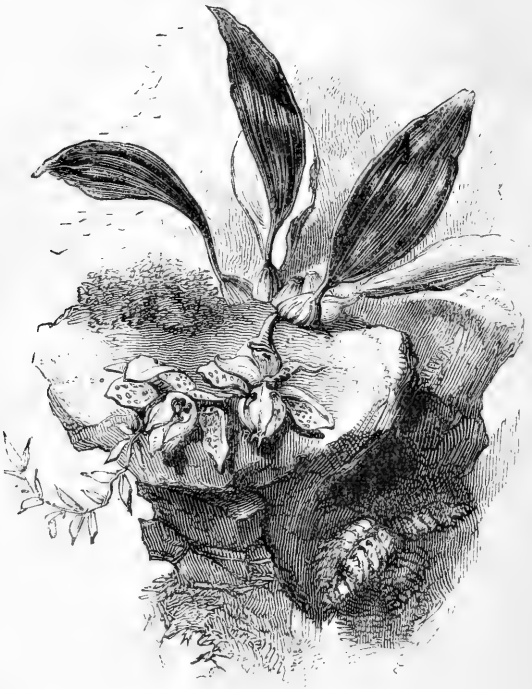
In old trees that are undergoing this last of changes, a great many agents help forward the process. Among these we must specially particularize the fungus or mushroom tribe of plants and the wood-boring insects. The latter are generally its first visitors; some of them attach themselves to the heart-wood, others to the bark, and in a short time these innumerable little carpenters will be found to have filled the trunk with their tiny mines, covered ways, and winding corridors; the wood then becomes saturated with moisture, and the process of decay advances rapidly. Now come the various species of mushrooms or fungi, and establish themselves on the decaying mass, presenting us with a strange and painful spectacle. By and by these too pass away, and perish, and then the venerable trunk has become one with the soil.

Long, therefore, though the majestic mass

of aged wood shewn in our Frontispiece may stand, there are secret, and silent, but powerful influences at work, which will eventually sweep it from the scene it now solemnizes and adorns. In the beautiful scheme of the creation, as laid down and carried out by the all-wise and powerful God, who has so clearly and graciously revealed Himself to us in His well-beloved Son, our Lord Jesus Christ, and in His holy word which He has given us, every created thing, after living out its time, dies, and after death the materials of which it was formed are returned either to the air as gas, or to the earth as water and dust. But with this difference : no resurrection morning will call together the lost particles of plants and animals,—but of man, the possessor of a never dying soul, it is written, while his flesh returns to dust, "his spirit shall return to God who gave it," and that *his* body shall be raised again, never more to return to the grave.

The hour, therefore, will certainly arrive when The Tree will be no longer seen, when the last work of decay and death will be done, and

when the green grass will wave over the place where for many a rolling century it stood and grew.



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