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THE MOVEMENTS OF PLANTS.

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PROBABLY no phenomenon in Nature excites so much attention and enquiry as movement. On perceiving the movement of any object, we almost unconsciously look for its cause. The movement of an apple falling to the ground from an apple-tree is said to have set the mind of Newton enquiring in a direction which ultimately revealed the law of gravitation.

The soporific influence of custom and habit appears to have had a less weakening effect upon the minds of men in this direction than in most others. I mean that the necessary relation between cause and effect is more generally admitted with regard to movement than other phenomena. A person, for instance, who does not so much as ask for the cause of any ordinary phenomenon, will often seek and look for the cause of a movement coming under his observation.

The cause to which the mind most readily refers movement is undoubtedly life. This is not to be wondered at, for that which we most intimately associate with our own vital activity are the movements of our bodies and of their parts. Thus it is that the savage, when he first becomes aware that the stars move in the heavens, believes that there is behind them a living cause; or when he first sees a locomotive in action, believes it to be endowed with life.

But in thus referring movement to a living cause, that cause is invariably associated with the animal world. Life, as far as it is associated with obvious movement, is invariably referred to an animal, not to a vegetal source. The very expression, "vegetable life," is synonymous with a quiet, peaceful, motionless existence.

In fact, so deeply has this idea become ingrained in the mind, that we have been religiously brought up in the belief that one, perhaps the great distinction between animals on the one hand and plants on the other is, that whilst the former possess, the latter are wanting, in the power of movement.

Unless there were a nucleus of truth in this idea, it would doubtless not be so generally entertained as it is. The extent of its truth depends upon what you mean by the word movement, when applied to living things—to animals and plants.

If by movement is meant locomotion, or movement from place to place, and we restrict our observation to the higher animals and plants, it is correct; but if, on the other hand, we turn our attention to the lowest forms of life, animal and plant, the distinction by no means holds, for here we find that the lowest plants, like the lowest animals, are endowed with the power of locomotion—they are able to move from place to place, by exactly the same means and in precisely the same manner, as do the lowest animals. Moreover, some lowly animals are fixed and incapable of moving from place to place. On the screen you see illustrations of a few such lowly plants. Here, for instance, is a lowly vegetal organism named *Myxomycetes.* It is nothing more nor less than a mass of structureless living matter, or protoplasm, which is capable of creeping about on any surface on which it may happen to rest. There are certain lowly animals, which are well known in the animal world, which are endowed with this curious creeping movement, and here in this little plant we see exactly the same kind of locomotion.

Here is a little plant which, under ordinary circumstances, is green or red. It is a little spherical mass of protoplasm, coloured green, and surrounded by a fine membrane. At one spot you observe two fine filaments, or cilia, which, by their active contraction, move the little particle through the water. In the animal world there are a great number of minute animals which are able to move about in this manner.

If by movement, on the other hand, you mean not locomotion, but movement of parts or members of an individual organism, the distinction by no means holds, as I shall endeavour to explain in this lecture. For recent observations, more especially those of the illustrious Darwin, have shown that all parts of plants—root, stem, leaf—are in a state of continuous movement so long as they are growing. As long as these parts of plants are growing they are in a state of incessant movement; in fact, the difference between the animal and the plant would appear to be rather this, that whereas the movements in the case of the former take place only now and then—in other words, are intermittent—the movements of the parts of the latter take place continuously, without intermission, so long as the parts are in a state of growth.

Now, this movement which is observed in the different parts of plants is of the nature of a nodding movement. It is a movement from side to side, and it is therefore usually spoken of by the word *Nutation*, from the Latin *nutatio*, a nodding. Now, this nutation or nodding movement of plants is of two kinds—(1) *simple*, when the part moves from side to side, in one plane only; or (2) *revolving*, when it moves more or less in a circle. Revolving nutation is also called *circumnutation* (Latin *circum*, around; *nutatio*, a nodding).

In the first part of the lecture I want to endeavour to explain the nature of this movement—its cause, and how, by simple experiments, it has been shown to be exhibited by the different parts of plants.

The next illustration on the screen will enable us to appreciate this kind of movement better. Here is an illustration of the simple nodding movement of the plant. You are supposed to be looking down upon the stem in its normal position, and you observe the marks supposed to be made by the top of the stem as it sways to and fro in one plane. That is simple nutation. But here is the revolving movement illustrated. You again look down on to the top of the stem, and see that it moves through each quarter of a circle until it reaches again the point from which we started. You notice that the side of the stem which faces the centre of the circle described varies as the stem revolves. After having moved through half-a-circle, the side which first faced the centre now looks directly away from it, or *vice versâ*.

The cause of the movement is inequality of growth. If one side of the stem grows more quickly than the other, by simple mechanical principles the stem will bend over on the side of lesser growth, and there is simple nutation. If the inequality of growth travels gradually round the stem, all portions of the stem will successively be forced out of the perpendicular, or normal line, and revolving nutation, or circumnutation, will be the result.

As to the means by which this movement is experimented upon, you have here a flower-pot containing a growing plant. A fine filament of glass, an inch or an inch and a-half long, is taken, at one end of which is fixed a little round knob of sealing-wax. About two-thirds of the way down a piece of paper is fixed, by the sharp end of the glass being run through it. At one corner of the piece of paper is put a black ink mark, and then the piece of glass—which weighs very little indeed, being very fine—is fixed at this end to the top of the stem. A large flat piece of glass is then taken and placed above the stem at right angles to it. Suppose, now, looking down through the glass plate from above, you fix your eye on the knob of sealing-wax at the end of the glass rod, and then move your eye until the knob of sealing-wax directly covers the black spot on the paper. When they are exactly in line, you make a mark on the flat piece of glass above. Leave the plant for an hour, and then go back and look at it in the same way, and make another mark. This is repeated again and again, until at last a considerable number of dots have been made upon the glass plate. Now join these dots together by lines, and you will find that the figure obtained approaches more or less that of a circle.

The next illustration shows a few tracings taken in this way. Here is the tracing obtained from a cabbage plant. The arrows, showing the direction of the movement, travel almost in the form of a circle. Of course I am not speaking of a mathematically-correct circle. Here are also another kind of cabbage and canary-grass, and here one of a cotton plant. This is the way in which the observations are made upon the stem.

The method adopted with the root is different, of course. You cannot experiment with the root beneath the soil in this manner. It is done in this way :—The tip of the root is allowed to grow down upon a slightly inclined glass plate, which has been blackened by being held over a smoky flame, and upon which the slightest pressure will make a mark. The end of the root is allowed to press against this piece of glass, and as it grows down you find a mark on the sooty glass curving from side to side. This is seen in the case of an oak plant on the screen. The marks in some places are finer than in others, showing that the tip of the root pressed more strongly sometimes against the glass than at other times, pointing to its not having merely moved from side to side, but to its moving more or less in a circle.

The next illustration shows us a young seedling plant. This is a pea. When you open a pea seed, you see within it the young plant. You observe at the top a little curved object; that is the very young stem. Then you notice a little pointed shoot below; that is the young root, or radicle. The mass of the seed is really made up of two very big leaves. They are the leaves of the seedling plant, and are therefore called the seed leaves. They contain a great deal of nutriment, which is used up by the young seedling when growing.

Here you have the seedling of the bean plant, which is closely allied to the pea. It has come out from the seed, and grown considerably: here you have the young stem, with the first ordinary leaves upon it; this is the young root growing down into the soil. I want you to notice that coming off from the root are a number of fine filaments. These are little hairs, and since they come off from the root they are called root hairs. Now, the movement of the root down through the soil is one which is worthy of a few moments' attention, inasmuch as the root is continuously exhibiting this peculiar revolving movement, which helps it to pass down through the soil. Of course when the root is surrounded by hard soil it cannot move in this revolving manner to any great extent. The nature of the soil prevents it. But remember it is always trying to move. Therefore, if, for instance, a worm should pass along near the root tip and push away the earth just by the root, the root moves, taking advantage of the space that the worm has left, and so pushes down more easily into the soil than it could when completely surrounded by it. In fact, this revolving movement of the root enables it to move down through the soil in the direction of least resistance. Whenever the soil is removed it takes advantage of that in virtue of being able to revolve. It is able in that way to grow down where the soil offers the least resistance.

The movement of the root down through the soil is aided in a much more wonderful way than that. I refer to the help rendered by the root tip, which is sensitive to contact and to moisture in a remarkable manner. Here you have a young, a very young seedling of buckwheat; here is the young stem with two leaves, and here you have the young root. The end of the root, or root tip as it is called, is extremely sensitive. When anything presses against the tip it moves away from the object touching it. For instance, supposing the root is growing down into the soil, and comes against a hard object, such as a stone, so that the tip presses on it, the root, instead of trying to push through the stone, creeps away and goes down by the side of the stone. It is worth while following the course of events here. What happens? You not only have the tip of the root moving, which has been touched, but a part of the root above the tip moves. The root moves completely away, so as to get round the stone, instead of pushing against it, and so it grows down into the soil, which it would not do if it were to remain against the solid stone. The point is this, that not only is the tip of the root sensitive to touch, just as your fingers are, but it is able to transmit that "touching" influence to a part of it above, and so cause the upper part to move as well. The tip of the root is not only sensitive to touch but to moisture. But the tip, instead of turning away from moisture, turns towards it. Now that again, you will see, is advantageous to the movement of the root down through the soil. Suppose the root happens to come near to soil which is rather more moist than that above. It will turn towards the moist earth, and, of course, it is easier to get through moist earth than through dry earth. The resistance is less. Therefore the sensitiveness of the tip to moisture which, instead of causing it to move away, causes it to move towards it, is equally favourable to the movement of the root down through the soil—in the direction of least resistance. These little root hairs also play an important part in enabling the root to penetrate through soil. The root hairs are simply little tubes, each consisting of an external membrane with living matter, or protoplasm, within. As the root is passing down through the ground, the little root hairs come into contact with the soil, and the remarkable fact is this, that the membranes become partially liquified at their extremities, so that minute stones, or particles of earth, become mixed up with it. The membrane then solidifies again, and in that way the end of the root hair becomes quite fixed in that portion of the soil. This fixing takes place in all directions. What is the result? It is this: that the root becomes fixed on all sides by the little hairs, and so any force within the growing root which acts in any direction must exert its influence in forcing the root down through the soil. A force within the root may tend to push it to the side or upwards, but it cannot do so when these little hairs are fixing it on all sides, and so any force is exerted in pushing it down through the soil. Let me conclude this portion of the subject with a quotation from Darwin:—

"If we look at a great acacia tree we may feel assured that every one of the innumerable growing shoots is constantly describing small ellipses, as is each petiole, subpetiole, and leaflet. The flower stalks are likewise continually revolving. If we had the power of a microscope, and could look beneath the ground, we should see the tip of each rootlet endeavouring to sweep small circles as far as the surrounding earth permitted. All this astonishing amount of movement has been going on year after year since the time when the plant emerged from the soil as a seedling."

Let me now refer briefly to the movement of the stem. I wish to explain a remarkable resemblance between the way in which the movement of the stem of plants is influenced by light, and the way in which our own bodies are influenced by the same agent. There is a striking resemblance between the influence of light upon the movement of the stems of plants, and the influence of light upon our own bodies—or that important portion of them which we call the nervous system. The interest attaching to this is due to the fact that nothing like a nervous system of the animal body is known to exist within the bodies of plants.

Now, there are no less than five different ways in which this analogy can be shown to exist :—(1) The small amount of light necessary to produce an effect; (2) transmitted effects; (3) in exhibiting an *after-effect;* (4) the stronger the stimulus the greater the effect; (5) the greater effect produced after darkness than after exposure to light.

To begin with, everybody knows that the human eye, which of course is part of our nervous system, is affected by a very small amount of light. We can appreciate extremely small quantities of light by our eyes. But, I think, even our eyes are surpassed by the sensitiveness of plants to light. I will just give one experiment. It has been known for a long time, and you are probably well aware, that plants are influenced by light in this way, that they turn towards the source of light. Everybody knows that plants on the edge of a forest will turn away from the inside of the forest, and to the exterior, which is more brilliantly illuminated. That is a fact that has been known for a very long time. The first point is that plants seem extraordinarily sensitive to light. A small seedling was placed in a pot, covered over with a tin vessel. In the tin vessel a tiny hole was made, one-twentieth of an inch in diameter. The light could just fall upon a certain portion of the seedling by means of this microscopic hole. When, after a time, the tin vessel was taken off, it was observed that the seedling had turned most distinctly towards the little hole. That small amount of light had affected the plant.

The next point is one which is analagous to the transmission of effect. For instance: say the plant is above the ground, and the stem is partially covered over, so that only the upper part of it is exposed to the light. You will find that not only will the upper and exposed part of the stem turn towards the source of light, but that the hidden portion will do the same. You can only explain this by the fact that the light not only affects the top of the stem, but transmits its effect to the lower part of the stem. We can readily understand that in our own bodies. When I look at a gas-light, I am aware of the fact. Why? The light acts upon my eye, but with that alone I should not know that the gas-light was there. The eye transmits the influence by means of nerves to the brain. There is a transmission of the effect that affects my brain, and I am able to see the light. Just in the same way, when the light affects the top part of the stem, it is able to transmit the influence of the light to its lower part, and cause that also to move.

The influence of light upon plants exhibits what we call an after-effect. You will have no difficulty in readily understanding that. I shall speak first of the after-effect in the case of the human body. Suppose you wake up on a fine sunny morning and look at the window. You see a striking picture of the window—the light panes and the dark sashes. You turn round, or without turning round you shut your eyes, and you still see before you, when your eyes are shut, the picture of the window; you see the bright panes and the dark sashes most distinctly. It is an after-effect. The meaning of that is, that the influence of the light upon the eye remains for a certain time after the source of light is removed. You have exactly the same thing in the case of the plants. Take a plant, for instance, and allow a light to act upon it, so that it moves at a certain rate towards the source of light; you then place the plant in darkness. What do you observe?—that the plant still moves in the same direction as it did before. It is an after-effect. The effect of the light does not stop directly you take the light away, for the plant still moves on as it did before. The light still exerts an influence—there is an after-effect.

The rapidity of the movement of the plant towards the light is proportionate to the intensity of light. It is quite unnecessary to mention, with regard to the eye, that the stronger the light acting upon the eye, the more we are affected by it. That will be admitted at once. It is exactly the same with the plant. If you allow a light of a certain intensity to fall upon the plant, it will move towards the light with a certain rapidity. If you then make another experiment, after carefully noting the rapidity with a stronger light, it will move more quickly towards the source of light; if you take stronger light still, it will move quicker still. You are brought to the conclusion that the plant moves towards the light in proportion to the intensity of the light.

Lastly, here is a most curious analogy between the animal and the plant bodies, and that is in the greater influence light has upon a plant after the plant has been in the dark. When you came into this room it was illuminated, but you did not experience anything unusual in your eyes. You were not struck by any particular brilliancy. The lights are now turned down for the lantern illustrations, but when they are turned up again presently, you will be conscious of the light acting upon your eyes, though it will not be any brighter than it was before. Your eye will be acted upon more strongly by a light of the same intensity, because, meanwhile, you have been in the dark. The same thing occurs in the case of a plant. Take a plant and allow a light to fall upon it for a certain time, and note the rate of movement; then leave the plant in darkness for some hours, and afterwards expose it to a light of the same intensity as before. It will be acted upon more strongly than before, and will move more actively towards the source of light than it did before being in the dark. In these five ways there is a very striking analogy between the effect of light on the movement of plants and its effect on the human body.

But this revolving movement of the plant is most strikingly shown in *Climbing Plants.* In fact, here it subserves a very important use indeed. It is due to the power possessed by certain portions of the climbing plants of moving in a circle that they are able to climb as they do. There are different kinds of climbing plants—hook-climbers, roof-climbers, twiners, tendril-climbers. The two last are the most common, and of those only I shall speak to-night. Everybody knows the nature of the hop or convolvulus plants, which climb up poles or stems by twining round them. On the screen we see this. Now, the way these plants manage to climb is simple enough; they possess this power of revolving in a very marked degree indeed. In fact, the last three or four, or sometimes five or six, joints of the stem move in a circle. When one of these plants comes first above the ground, of course there may be no stick or anything round which it can climb. It will begin to move, the uppermost joints sweeping small circles. It is trying to find something round which it can twine. When the hop-grower comes upon the scene, he sticks a pole into the ground. It is put into the middle of the circle, as it were, made by the revolving stem, and then the stem comes into contact with it, and of course twines around it. The part which becomes pressed against the pole ceases to grow, and becomes fixed against it. That portion which moves round in a circle is the growing portion of the stem, and as it grows it moves up the pole, for the circles will in reality be parts of a spiral. This is very strikingly shown in the "Morning Glory" on the screen. In a plant (*Ceropegia Gardnerii*) observed by Darwin, the part of the stem that revolved was no less than 32 inches long—nearly a yard. In that way the diameter of the circle swept would be something like two yards. The circle itself once established would be something like six yards, or nearly 18 feet. Darwin took the plant into his study and placed it on the table, and it continued to move—it moved at the rate of half-an-inch a minute. Darwin says it was a most interesting spectacle to watch the long shoot sweeping this grand circle continuously, night and day, in search of some object round which it could twine.

The second class of plant comprises the tendril-climbers. The Mexican Passion Flower in the screen is one of these. A tendril is a very fine filamentous body, which does not end in anything. It does not end in a flower or a leaf. These tendrils have the power of revolving in a marked degree. But over and above that, they are extremely sensitive. If you go into a hot-house and touch a tendril with a stick, it will soon bend, and afterwards perhaps coil up. It is sensitive to a touch. This is especially the case with the termination—the end of it. When this end comes into contact with a hard object, it is so sensitive, it gets hold of it, and coils around it, and becomes firmly fixed to it. We have here also a very striking example indeed of the transmission of effect. What we saw in the root and the stem, we see in a most marked manner in the case of the tendril. The effect produced on the end of the tendril by its sensitive nature is transmitted to the whole of the tendril, or nearly the whole of it, in such a way that it becomes coiled in a beautifully spiral manner. This subserves two very important purposes. By coiling in that way it simply hauls up the stem of the plant, thus raising it to a higher point. If you cut off the tendril, and pull out the coil, it will be two or three times as long, and so you see how considerably the coiling must pull up the stem. But this coiling of the tendril also subserves another purpose. The spirally-coiled tendril acts very beautifully as a spring. That is a useful purpose indeed, for a strong wind would blow the plant out of its position. The tendrils are extremely delicate, and the slightest strain would break them. But the coil acts as a spring before the wind, and the tendril is blown against without damage. It is stretched, and when the wind has gone down, it resumes its proper length. Here on the screen is a Vine and a Virginia Creeper, which so easily grows up against the sides of walls and houses. At the end of the tendril of the Virginia Creeper are very curious little bodies that might be called flat suckers. The end of the tendril becomes firmly fixed and pasted against the wall by means of this little sucker-like body, and the plant is thus enabled to become fixed against any perpendicular flat structure like a wall.

Sleep Movements.—These movements every child has observed in certain flowers. The sleep of leaves is far more common, however. Recent observation has shown that an enormous number of leaves of different kinds of plants exhibit this sleep movement. The peculiarity may be briefly summarised by saying that the leaf at night puts itself into such a position that the blade is perpendicular to the zenith. The leaf, of course, in the day-time is flattened out, exposing its upper surface to the sky. At night it is at right angles with the sky, so that neither the upper nor the lower surface is exposed to the sky. The trefoil leaf of the clover may be instanced, which you see on the screen in both its normal and sleep position. Here, too, is the Marsilea, a pretty water plant. This Acacia which you now see is another. You may have observed the Telegraph Plant in hot-houses; some of the little leaflets of which the leaf is composed are continually moving up and down—hence its name. At night the leaves fall so as to be almost perpendicular, as is well shown by the illustration on the screen.

As to the use of these sleep movements:—Their use appears to be to protect the leaves from chills and frost at night-time, by diminishing the loss of heat by radiation. That plants do suffer from this cause is acknowledged by the custom of protecting seedlings and fruit trees, by covering them in cold weather. Direct experiments have been made which point to this conclusion. The nature of these experiments is this:—To compare the effect of cold or even frost at night on leaves of two similar plants, one of which is allowed to go to sleep in the normal manner: the leaves of the other are prevented from sleeping by being pinned out in their diurnal horizontal position. On the leaves of the former very little dew is deposited, and they are not much, if at all, injured by frost. On those of the latter much dew is deposited, and great numbers of them are blackened and killed by frost. Hence it is obvious that the sleep movement is of a protective nature as far as injury to the plant arises from loss of heat from the flat surface of the blade of the leaf, or from loss of heat by radiation.

Touch Movements.—In conclusion, I shall refer briefly to another kind of movement, which is best known, and for some reason is perhaps the most interesting, though not the most common. These may be called touch movements. I will take two examples:—The Sensitive Plant (*Mimosa pudica*); and the other, Venus' Fly-trap (*Dionœa muscipula*). The leaves of both these plants exhibit a very remarkable movement when they are touched. Here is one leaf of the Sensitive Plant on the screen. If you touch the last leaflet of this compound leaf—the leaflets of which, being arranged like a feather, is sometimes called a pinnate leaf—the leaflets all close up one after another, in a very beautiful, regular movement. When this is finished, the whole stalk of the leaf falls; the leaf is then said to be in the excited state, which is well seen in the illustration on the screen. You have here one of the most striking examples in the whole of plant life, as far as we know, of the transmission of effect. When you excite the last leaf, you only touch the very last leaflet; and what is the result? You get the movement of leaflets a long way off, and, further, you get the movement of the whole stalk—simply as the result of touching one tiny leaflet at the end. When I touch the table I am aware of the fact, because the effect of the touch is transmitted to the brain by means of nerves. We can understand this in the case of the human body, where you have a nervous system. But in plants, so far as we know, we have no nervous system, and this phenomenon has therefore much excited the attention of physiologists, and they have been much puzzled to find a suitable or satisfactory explanation of what superficially appears so simple. The proximate cause of the fall of the leaf is, however, known, and this is what I want to endeavour to explain. You notice that at the end of the stalk by which the leaf is attached to the stem is a little oval enlargement. From a fancied resemblance to a cushion, it is called the pulvinus (Latin for cushion) of the leaf. This little pulvinus is nothing more or less than a beautiful mechanical contrivance by which the leaf is enabled to fall down when the end of it is excited. What happens, though we cannot exactly explain how the excitement travels from the tennial leaflet to the pulvinus, is this:—When you take the last leaflet between your finger and thumb, and stimulate it, the effect passes right along the leaf, until it reaches the pulvinus. On arriving there it alters the constitution or the mechanism of this curious cushion-like enlargement in such a way as to cause the leaf to fall. A change takes place within the cushion-like body, or pulvinus. On the screen is a microscopic view of a pulvinus cut down through the middle. In section it is circular. There is a woody mass in the centre, around which are great numbers of what the physiologist calls cells, containing living matter and water. The walls of the cells in the upper half are thicker than those forming the lower half. The real mechanism is composed of the cells of the lower half, and what takes places is this:—When you touch the end leaflet the effect is transmitted to the pulvinus, and by some means, which we do not fully understand, causes the cells in the lower half of the pulvinus to discharge some of their contained water into the spaces between the cells which previously contained only air. As a result of this the little cells of the lower part, instead of being distended, become flabby. The change might be compared to a number of bladders passing from a condition in which they are strongly distended by contained liquid, to the slack state ensuing on the passage out of some of the water. What is the result? That the stalk being no longer supported by the mass of distended cells forming the lower half of the pulvinus, falls in virtue of its weight.

A word or two regarding the Venus' Fly-trap. This plant is carnivorous—it is able to make use of insects as food. Each leaf consists of two symmetrical halves. On the upper surface of the leaf there are extremely sensitive hairs—three little hairs on each half. If an unfortunate insect touches a hair, it is caught in a trap; the two valves very soon closing up, thus imprisoning the insect as you see in the illustration on screen. The leaf gives out a digestive liquid, and the insect is thereby made suitable for absorption by the plant as its food. Now, in this case you have a contractile organ of some kind by which the leaf, on being excited, is moved so as to close up in the way I have described.

In animals we have markedly contractile organs, or more strictly speaking, tissue—viz., what we call muscle. The evident existence of contractile tissue in animals and plants has led to a close comparison of the two; and with very remarkable results, to which, in conclusion, I will briefly allude. It has been known for a good many years that the muscular tissue of animals—the contractile tissue of animals we call muscle—exhibits certain electrical phenomena—what physiologists call the muscle current. Physiologists have proved that when these muscles undergo contraction, the muscle current becomes diminished in intensity—undergoes what is called a negative variation. The enquiry was therefore made, "Does the contractile tissue in plants exhibit similar electrical phenomena?" Experiments on the Dionœa plant have shown that it does. There is a leaf current just as there is a muscle current, that when the leaf contracts by closing up, the leaf currents also undergo a change, exactly similar to the change which the muscle current undergoes when the muscle contracts.

But that is not all. Suppose you take the muscle and throw an electrical shock into it, causing it to contract; the muscle does not contract directly you send the shock into it. A very short time elapses first, as can be shown by delicate physiological instruments. There is a sort of hesitation period, as if the muscle were making up its mind whether it should contract. It is in this period that the change in the muscle currents, its negative variation, takes place. When you make an experiment with the Venus' Fly-trap, you also find this hesitation period. A certain period elapses between the moment when you stimulate the leaf and the moment when it closes up. Further, the change or negative variation in the leaf current in the plant also takes place in this period. The analogy, therefore, between the contractile tissue of the animal or muscle, and the contractile tissue of the plant, as exhibited in the Dionœa, is as complete in every particular.

There is one more fact that is more striking still to my mind. It has been shown that these hairs are sensitive only to touch. They must be touched by something. The most interesting point is this: they are most sensitive of all to a human touch. Professor Burdon Sanderson, on whose authority I make this interesting statement, could come to no other conclusion than that the stimulus which causes the leaf most readily and actively to contract is a human touch.

What is a human touch? A human touch is the result of a combined contraction of a great number of muscles, of the contractile animal tissue; and his observation tells us this—that that which most readily causes the contractile tissue of this plant to be thrown into activity is a stimulus resulting from the activity of the contractile tissue—the muscle of an animal. One might almost say that in this case there is some magnetic sympathy between the contractile tissue of the animal and the contractile tissue of the plant.

It would be very unbecoming in me if I concluded this lecture to-night without referring to the illustrious man of science to whom we are so much indebted for so many of the observations and results which I have briefly brought before your notice to-night,—observations which, apart from their inherent interest, have a charm of their own, inasmuch as they formed almost the concluding and crowning work in the most laborious life of the greatest of modern naturalists: the work of one whose marvellous powers of observation, whose unrivalled genius for the interpretation of nature, whose devotion to the scientific spirit, whose fidelity to truth, calmness of judgment, and fairness in controversy, should make him the master of every student, of every lover of nature—Charles Darwin.

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