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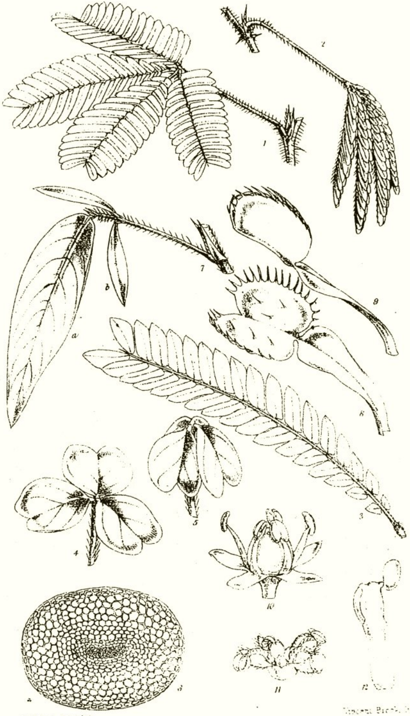
It seems as unreasonable to complain and be astonished, when a serious accident from storm occurs in such a spot, as it is for the capitalist who invests in a speculative security at a high rate of interest to feel aggrieved when his security is found to be somewhat unsound. The speculator must be presumed in each case to have estimated the risk, and acted accordingly. We venture to offer these remarks, not to check the liberality of those who, after a disaster of this or any other kind, do their utmost to sympathise with and help innocent sufferers, but simply to show the real state of the case. The hurricane that swept over the harbour of St. Thomas and the adjacent island of Tortola was not in any sense an extraordinary phenomenon. It was one of a class foreknown, foreseen, and certain to happen at one time or other. The risk might have been calculated in any required terms ; and as far as the West India Mail Steamboat Company were concerned, it appears that their Insurance fund provided for their loss in ships and money. Unfortunately, although we may insure human life for the benefit of the survivors, we cannot replace the life sacrificed—and life being lost, money cannot pay for it. Thus there is a sad and painful feature in these events, admitting of no comfort ; and naturally enough the human part of the question is so prominent in the eye of human beings that they are apt to forget or ignore the greater cosmical question which is also involved.

(Popular Science Review Jan 1868)

SENSITIVE PLANTS.

By MAXWELL T. MASTERS, M.D., F.L.S.

ANATOMISTS and physiologists, both alike interested in studying the manifestations of life, the one studying the working, the other the organisation of the machine, have naturally turned their attention to the vegetable world, in the hopes that the simpler structure of plants would yield a clue towards the deciphering of many a problem in animal physiology. The physiologist, by the careful observation and comparison of the several organs in various groups, from the highest to the lowest, has been enabled to make great strides towards a right understanding both of structure and function. The machine has been pulled to pieces, and its action has to a great extent been elucidated. What more natural than to suppose that a similar process carried on in the case of plants would lead to analogous results; and yet the present state of vegetable physiology is often said to bear unfavourable contrast to that of the animal kingdom. It can hardly be said that the vegetable physiologists are less active than their colleagues, or that their means and appliances are inferior. What, then, is the reason for the alleged greater proportionate advance of the one than of the other department of the history of life? The main reason, as has been often pointed out, is the comparative simplicity of plant structure as compared with that of animals. It is comparatively easy in the case of the latter to assign a particular use to a certain organ having a certain structure, or occupying a definite position. All this is a matter of easy observation; but in the case of plants we find organs, to all appearance, essentially the same as to structure performing widely different functions. If a student of the animal kingdom saw the same organ performing at one time the functions of absorption, of exhalation, and of secretion, he would be as much embarrassed as a botanist is when he comes to investigate the functions of the leaf. And after all, when the matter comes to be sifted down, there is no such great difference between animal and vegetable physiology as to their relative status. In the presence of the cell, simple enough in its structure, but widely diverse in its mode of action in different cases, the physiologist, whatever



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SENSITIVE PLANTS

branch of the science he may study, stands abashed. Watch the passage of fluids from one cell to another; nay more, strip off the outer coating of the cell—the cell-wall—and leave the little dab of slime, as it has somewhat contemptuously been called, and watch its sometimes active movements; see it contract and expand, observe the chemical changes that take place in it. Where now is the difference between the animal and vegetable physiologist? Is the one better able than the other to cry "Eureka, this is the mystery?" Can the one float better than the other in the sea of knowledge, or are they not both equally at fault? Nevertheless, the experience of the last few years has shown that the investigation of these humble cells and their doings is, in all probability, the one path by which the physiologist has to travel in order to unravel as much of the mysteries of life as it may ever be granted to man to solve.

Motion among animals implies a muscular apparatus of some sort or other; it implies a sensibility to external impressions, and, at any rate in the higher groups, a greater or less degree of volition, and as a consequence a nervous system. In the case of plants, there is motion of various kinds; there is evident sensibility to external impressions; and there is evidently a power of transmitting impressions from one part to another. But, so far as structure is concerned, there is no muscular system—no nervous system, at least in the sense in which those terms are usually employed. The lowest animals, those debateable creatures concerning whose nationality such contests have been waged, are no better off. Where is their muscular system? Where are their nerves? And yet they move, they show a repugnance to noxious agents, they are evidently in a degree sensitive. Clearly then, the essential attributes of both muscular and sentient structure are to be sought among these humble organisms, plants or animals, it is indifferent in which division they are placed. And, as has been before said, there is no room for glorification on the part of one naturalist over another. Both are alike ignorant. Travelling by two different roads, they have come to the same point, picked up much information on the way; so much that neither the one nor the other have the least doubt of accumulating a great deal more in due season.

In the present article we hope to be able to present to the reader a sketch of what is known as to the movements excercised by plants, and specially by those usually termed "sensitive plants." And here it may be remarked, that the actual movements exhibited by sensitive plants are not materially different, except in degree, from those more general movements which, from being always under our eyes, attract less attention than they would were they only occasionally visible. For instance, the elevation and depression of leaves according as they are "awake or asleep," phenomena obvious enough in many plants; the folding and unfolding of flowers; the movements shown by tendrils and climbing plants, to which Mr. Darwin has recently drawn so much attention, and a summary of whose researches, from the pen of the Rev. George Henslow, appeared in the pages of this *Review* last year. These, together with the movements observed in the stamens and pistil, in connexion with the fertilisation of the latter organ, are probably, if not certainly, effected by similar means, even though those means be called into action by different circumstances. Allusion may here also be made to the movements observed in the branches of trees in frosty weather. In the Report of the Proceedings of the Botanical Congress, London 1866, is an elaborate paper by Professor Caspary, showing the effect of cold in inducing these movements, the direction of which varies in different trees, and the amount of which is generally in direct proportion to the intensity of the cold. Dr. Caspary, however, has not been able to ascertain how the cold produces these actions. Motion by the action of ciliæ—as marvellous a phenomenon as any—appears to be confined to the simplest organisms in the plant world, which do not come strictly within the limits of this communication. But inasmuch as it has a relation to other facts, to be hereafter alluded to, we may call attention to the action of light on these lowly creatures. Dr. Ferdinand Cohn, amongst others, has clearly shown that the direction in which these plant cells move is influenced by the direction in which the light falls. They move towards the light, turning their ciliated ends towards it, while the remainder of the cell which, unlike the part just mentioned, is filled with chlorophyll, is directed away from the light. If the rays be prevented access no movement at all takes place, and while the red and the calorific parts of the spectrum generally have no effect, the blue and violet rays are specially powerful in producing the effect. The motions shown by the *Oscillatoriæ* can hardly be passed without mention, though in truth little is known concerning them. The plants just named are simply cylindrical cellular tubes, endowed with a peculiar undulatory movement which is exerted by the gelatinous contents of the cell, rather than by the cell wall. So much is made out, and it is of great significance, as showing that, as is the case with almost all the other principal phenomena of life, it is the protoplasm which is the seat of activity and not the outer cell wall. This contractile power of the protoplasm is seen in no plant better than in the *Selaginella mutabilis*, now often to be met with in hot-houses. This plant, under the influence of bright light becomes of a pale whitish colour, as though milk had been spilt over it, but when the intensity of the light is less it resumes its green colour. The microscope plainly shows that in the former condition the protoplasm is contracted into a round ball, while in the latter state the endochrome is diffused throughout the interior of the cell. No general movement of the whole frond is perceptible here, and the circumstance is merely alluded to as showing in a marked degree the contractile power of the protoplasm, and as offering grounds for the conjecture that some of the movements in plants may be attended by a like contraction. It is much to be desired that some one with the necessary leisure and appliances should institute experiments on this singular little Lycopod.

It seems clear at any rate that light has as much to do with the movements of some of the lower organisms as it has with the direction of branches of leaves and flowers. Here also we may refer to the extraordinary rhythmical tremors observed by M. Lecoq, of Clermont, in the leaves of *Colocasia esculenta.* These are stated to occur at intervals, the plant in the meantime being perfectly at rest; so violent are the vibrations, according to M. Lecoq, that on one occasion the very pot in which the plant was growing shook so violently that it could with difficulty be steadied! This statement has been confirmed by another French naturalist. It may be remarked that the emission of water from a pore near the apex of the leaf has been occasionally observed; hence it has been suggested that in the case of M. Lecoq's plants, the tremors may have been occasioned by the efforts of the plant to rid itself of the water. Certain it is that in many cases no such aperture is visible in the plant in question, and that the emission of water is not by any means a common phenomenon. We must wait for fuller details before it can be decided whether the perforate or imperforate condition of the leaves has anything to do with the actions in question. Prof. Lecoq is too well known as an acute observer to allow of his statements being questioned on light grounds.

Adverting now to "sensitive plants," specially so called, apparently from the fact that the movements they exert may be set in action by mechanical agency, as by a touch with the finger or other object, by a breath of wind, &c., it may be remarked that the numbers possessing this property are much larger than is usually supposed.

Leguminosæ and *Oxalidaceæ* afford the greatest number of such plants, and they have this in common, that the mobile leaves are "compound," consist not of one piece, but of several secondary leaflets, jointed to a common stalk, the "joint" being evidently the part most concerned in the movements that take place. *Mimosa pudica* and *M. sensitiva* are the two "sensitive plants" most commonly grown in this country. In either, a slight touch upon the extremity of one leaflet causes the depression of that leaflet, then of its neighbour, and so on in succession till, according to the force of the blow, the whole series become folded together, the secondary leafstalks fold together like the ribs of a fan, and the common stalk drops by the side of the stem. After an interval, the plant recovers its equilibrium, and the original position of the leaf is restored. Similar movements occur at night, constituting "the sleep" of the plant. Some of the tropical species of *Oxalis* show similar phenomena. Unlike our common Oxalis (*O. Acetosella*), the plants in question have long pinnate leaves similar to those of the *Mimosa pudica*, and at the least irritation they close their leaflets as in the last named plant; in some instances, however, raising the leaflets instead of depressing them. By the older botanical writers the Oxalis was known as the "Herba sentiens;" and Rumphius, who gives a full description, as well as a figure of it, expresses his surprise that in Amboyna the plant should be so often found in exposed places, where it would seem most likely to be exposed to violence, adding, somewhat facetiously, that it is like a young lady who wishes to be looked at, but not to be touched!

One quality was attributed to the Oxalis which, did it really possess such, would render the services of the "Professors" who undertake the delineation of character from an inspection of the handwriting superfluous. So chaste was the plant that its leaves collapsed in the presence of vice, and hence it was made, so runs the tale, to serve as a sort of test, to eliminate the good from the bad, to act as a love-philtre, and even to expurgate the guilty and render them as free from taint as itself. It is a pity the herb should have lost its virtues in these days!

This *Oxalis sensitiva*, probably in its native country the most amenable of all plants to external influences, is in this country quite, or nearly quite, destitute of the power of closing its leaflets when irritated; a circumstance that should not be overlooked when casting about for the causes of the phenomenon. Our common wood-sorrel has the power of depressing its leaflets at night and of raising them in the day; but does not seem to be sensitive to mechanical stimuli.

The Fly-trap *Dionæa* is another of the best known of the sensitive plants. It is closely allied to our Sun-dews, *Drosera*, the leaves of which are also said to be endowed with a certain sensitiveness—so feeble, however, that but few have ever seen it. In the *Dionæa* the upper half of the leaf folds in halves, like a sheet of note paper when an insect happens to touch one or more of the hairs which beset its surface. A "chevaux-de-frise" of bristly points surrounds the margin of the leaf, so that the unlucky insect remains a prisoner till it dies. What possible object the plant has in thus catching flies, or what is the real purport of the peculiar movement, no one knows, though, as may be supposed, speculation of the wildest character has been indulged in concerning it.

One more illustration—perhaps the most extraordinary of all—is afforded by the Telegraph plant, *Desmodium gyrans*, a native of India. The leaves of this plant consist of three leaflets—two small lateral ones, and a third, much larger, terminal one. If the Desmodium be watched, the terminal leaflet may be observed to move upwards or downwards, according to the intensity of the light; the lateral leaflets having a still more vigorous and perfectly independent action, recalling that of the old Semaphore signals, and one which is going on day and night alike, and hence is unaffected by the light. The action of these smaller leaflets is so singular as to demand a more exact description than is called for in the other instances. Supposing one of the smaller leaflets to be in the horizontal plane, if watched it may be seen to rise by a succession of little jerks, keeping its point and upper surface directed towards the stem. When it has attained a nearly vertical direction its companion leaflet begins to descend, turning its upper surface away from the stem as it falls. Having descended to the horizontal position, the other leaflet begins to rise again, and so on. Electrical and mechanical stimuli appear to have no effect on these movements, though heat and moisture accelerate them. They are perfectly perceptible in our stoves, but less so than under natural circumstances. These motions are, perhaps, the most mysterious of any, and, though much has been written concerning them, we know little more than when they were first brought under the notice of the scientific world by Lady Monson, in the latter part of the last century.

The phenomena that take place in the flower are not less worthy of observation than those of the stem and leaves. The folding and unfolding of the flowers, sometimes at regular hours, did not escape the observant Linnæus, since whose time, indeed, but little addition has been made to our knowledge of this branch of the subject; but it is one that sadly requires fuller investigation. How is it, for instance, that the Sidas of India expand their flowers in the morning only, while the Abutilons, which scarcely differ from them in any point of structure, yet unfold their blossoms in the evening only. The movements that take place in the stamens and pistils have, however, attracted more general attention, because in many cases the mobility is excited by mechanical stimulus; a slight touch with a pin or the antenna of an insect will suffice to cause the stamen of *Berberis* to bend suddenly inwards towards the stigma, there to deposit its pollen. But the mere enumeration even of the many instances of mobility in connection with the dispersal of pollen or of the seed would occupy more space than we can give to the subject, and so we pass on to the anatomy of the mobile organs. We cannot, of course, give the details in every case where motion has been observed, but we may state in general terms that it has been well ascertained that the mobile property resides in the cellular tissue *par excellence*, and is not primarily, at least, manifested by the woody or by the vascular tissues, though these may serve to transmit the impressions from one part to another. This holds good in the parts of the flower as in the leaves. It may be as well, however, to describe the general structure of the little swelling (*coussinet* of the French) that is so generally found at the bas of the leaflets, and also of the leaf in those cases where they are endowed with the greatest mobility, merely stating that the presence of the "coussinet" does not always accompany the property of raising or depressing the leaf. The structure of the coussinets is readily made out, by an examination of transverse or longitudinal sections, from which it may be seen that there is in the centre a small quantity of pith cells surrounded by a ring of fibro-vascular tissue; longitudinal slices show that this ring is formed by the coalescence of groups or bundles of vessels which in the leaf-stalks are separate. Outside the fibro-vascular ring are three or four layers of cells—the inner ones containing starch grains, the outer ones chlorophyll; they are comparatively loosely aggregated, so that small spaces are left here and there between them. Next in order from within outwards is a much thicker layer of cells, so closely packed as to present no intercellular spaces, and which are filled with chlorophyll, and frequently with some powerfully refracting substance of an oleaginous nature; investing this thick cellular layer is the ordinary epidermis, destitute of stomata. Similar structural arrangements exist in all the "sensitive plants" yet examined. Now, as to the action of these layers of tissue, Sachs*—many of whose experiments we have repeated—has shown that, if thin transverse slices of the coussinet be thrown into water, the thick outer layer of cells, in which there are no intercellular spaces, becomes distended and turgid; and when a longitudinal section is made, as the outer cells are fixed, on the one hand to the epidermis, and on the other to the central tissues and to the vascular ring, the two ends of the section become bent, while the central portion, being fixed, remains comparatively unaffected. If the slice be bisected there will be a double curvature, the portion attached to the epidermis curving in one direction, that fixed to the central bundle bending in the opposite direction, the concavity of the curve in either case being necessarily on the same side as the point of attachment. It would appear that the turgescence of the cells in this case is due to endomose, as when the sections are placed in sugar and water the direction of the curves is reversed.

Experiments of a like nature were made many years since by

* Bot. Zeitung, 1867.

Dr. Golding Bird, who showed that the curvature which takes place when the stalks of herbaceous plants are divided vertically is due to osmotic action. Similar phenomena were observed by Morren in the mobile styles of *Goldfussia* and *Stylidium*. As regards the sensitive plant, it has been shown by isolating the cellular from the fibro-vascular portions, by means of incisions, above, below, and to either side of the central cord, that the cellular tissue so liberated becomes lengthened; hence, all the while it remained attached to the central cord it must have acted like a spring, or rather as a double spring, one on one side, one on the other. When the force exerted by the one equals that of the other the leaf is retained in the horizontal position, but if the equilibrium be destroyed, the leaf falls. This equilibrium may be destroyed either by the superior energy of the upper spring, or by the diminished force or temporary paralysis of the lower one, owing to which the upper spring is able to push down the leaf and keep it down till a renewal of force in the lower cells replaces the leaf in its natural position. This latter explanation is the one that is generally accepted by physiologists.

Anatomy, then, points to the rush of liquids from certain cells, and to the turgescence of others, as the cause of the movements, equilibrium being restored when the fluids again become diffused. Assuming that this unequal distension of certain cells is at least a general concomitant with the motions in question, it remains now to trace the causes that set them in action. Some of these, such as light, especially the blue rays, and heat have been already alluded to; but we have still to allude to the effect of what may be termed mechanical stimuli, including in that term agents that act chemically. Sensitive plants have been subjected to almost as many experiments as rabbits or frogs. A volume would be required to give the details; all that it is necessary to do in this place is to state the general results. The effects of contact with the finger or other object, the result of a puff of wind or a drop of water, on sensitive plants are well known. Touch them, and they shrink from the blow by whatever means it be inflicted. Vibration, even without actual contact, is sufficient to set the leaves in motion. A footstep in their native country makes the leaves close; in other cases, as we have seen, the touch of an insect ensures the motion of the leaf or of the stamen. Sensitive plants, however, are apt, like other creatures to get more or less accustomed to external influences, to get exhausted, and so after a time become indifferent and lose their mobility. A curious instance of this is seen in the experiments performed by Desfontaines, who carried a Mimosa about with him in his carriage. The poor plant at first manifested its usual signs of sensibility, but by-and-by it ceased to respond to the stimulus, and its leaves became motionless.

We can testify to similar results, from conveying a specimen by railway. The circumstance that most of the sensitive plants are more active in their native country than with us has been already alluded to, and we may add, as a fact of equal significance, that towards the close of the year when the *Mimosa pudica* (an annual) loses its leaves and ultimately dies, the sensibility to external impressions is much more feeble than when the plant is in full vigour.

Opium, ether, chloroform, all exert a paralysing influence on the leaves. Strong acids and other caustic substances, on the other hand, induce contraction at once. With reference to the action of ether, we may relate the result of some trials that we have recently made with that fluid. On allowing a drop to fall on one of the leaflets of *Mimosa pudica* from a height of five or six inches, contraction of the leaflet instantly took place, and was immediately followed by the motion in successive order of the adjacent folioles proceeding from the apex towards the stalk of the leaf. When, on the other hand, the drop of ether was placed as gently as possible on the surface, the leaflet did not move, but seemed paralysed by the anæsthetic agent, while the adjacent ones not touched by the ether moved as in the preceding case. Ether-spray applied with the jet had precisely similar effect. When the spray fell directly on the leaflets, that is with some force, the impact of the falling drops counteracted any paralysing power that the ether might have; but when the spray was so directed as not to fall directly or with force on the leaflets, then such of them as came within its influence were rendered motionless, the adjacent folioles contracting from the distal towards the proximal end of the leaf as before. A spray of water directed on to the leaflets caused them to fall, but if not allowed to impinge directly on them no motion ensued, though of course the water did not, as the ether did, stop their mobility, as a touch was sufficient to make them collapse after the water-spray, while after the ether-spray contact produced no effect.

The effect of the ether-spray on certain other plants was, in two instances, so remarkable that a record may here be given, though it must also be borne in mind that the results now to be mentioned were only obtained in two instances out of many trials on various plants in hot-houses, in the end of November of the past year (1867). On applying the spray to the extremity of one leaf of *Iresine Herbstii*, which from having been grown in heat was what gardeners call "drawn," that is, had comparatively long intervals between the leaves, and a flaccid texture, a thin film of ice was speedily produced on the distal end of the leaf. In less than two minutes the whole shoot, four to five inches long, was observed to bend quickly downwards, forming as it did so a curve whose concavity was downwards. Next morning the whole shoot was dead. To what precise circumstances this rapid transmission of the effect from one end of the shoot to the other, and its ultimate death, are due, it would be premature to assert, as it is difficult in such a case to eliminate the irritant effect of the ether (clearly it did not here act as an anæsthetic) from the effect of the cold and ice produced by its rapid evaporation. It may here be stated, that two or three drops placed on the leaf in the ordinary way had no effect at all. A few days after, similar trials were made in the Botanic Garden, Chelsea, on some plants of the same species, grown in a colder house, and which were "shorter jointed" and altogether firmer in texture. In these instances no other effect was produced than the death of the leaf. The other case to which allusion may be made was a *Maranta*, also growing in a stove, and in which the application of ether-spray to the tip of a leaf caused it to roll up on to the under side like a roll of paper. In the young state the leaves of this plant are rolled lengthwise (convolute), but the effect of the ether was to cause the leaf to roll up along the under surface from the tip towards the stalk. Similar experiments were tried on other Marantas, but without effect.

Now, though of course little stress can be laid on these experiments, they appear to be worth recording, as suggesting other trials at a more favourable season—trials from which possibly something may be learnt as to the movements of plants, the propagation of impressions, the action of irritants, or of frost.

So suggestive a matter has not been lost sight of by the students of electricity; the results, however, of electrical experiments are somewhat conflicting. Some months since, Dr. Sigerson, who was corroborated in his statements by Dr. Divers, stated that the leaves of the sensitive plant when touched with glass (a non-conductor) failed to exhibit their customary sensibility, but if touched with steel or other good conductor the usual results were at once manifested. Dr. Sigerson even stated that he felt a painful sensation in the ulnar nerve at the right elbow (the funny-bone) after having touched with the little finger of the same side the leaf of the *Dionæa*. On repeating these experiments ourselves on several occasions we have not seen any difference in the effect of glass or other substance used to touch the leaflets. Mr. Hamilton, writing from Grey Town, Nicaragua,* where the *Mimosa* grows wild, also repeated these experiments without the results seen by Dr. Sigerson, but he confirms the opinion expressed by that gentleman that children affect the plant's movements more than adults do. Dr. Sigerson even hints that the movements are more active when excited by a person in a "tonic" condition than when he is weary or exhausted. M. Blondeau, one of the most

* Gard. Chron. 1867, p. 31. (Extract from the Athenæum.)

recent experimenters, and the account of whose researches is given in the *Comptes Rendus* for the present year, found that when a current from a galvanic battery was passed through the leaves, no result was produced and that the plant did not respond to the stimulus. On the other hand, when in place of the direct an indirect current was employed, by the use of a small Ruhmkorff's coil, the results were entirely different—the leaflets folded up and the leafstalks drooped along the whole course of the stem. If the current were continued for a short time the plant after a period of repose raised its leaves and resumed its ordinary state; but if the experiment were prolonged for twenty-five minutes the organism seemed to become entirely exhausted, and the following day was found withered and blackened, as though struck by lightning, and the same effect has been noticed by M. Bert. Still more remarkable were the effects noticed when the plant was allowed to come in contact with the vapour of ether. Induction currents of electricity have little or no effect on animals when under the influence of anæsthetic agents. In order to see what would be the effect in the case of the *Mimosa*, under like circumstances, M. Blondeau exposed a specimen to the anæsthetic effect of a few drops of ether sprinkled in the glass enclosing the plant. In a short time, says M. Blondeau, the plant experienced the effect of the anæsthetic—its leaves refused to move when shaken, and manifested no sensibility even when the induction current was passed through them.

From what has been stated it will be evident that we have yet much to learn as to the causes of the movements observable in the vegetable world. Different plants act differently under the same circumstances, as in De Candolle's experiments with artificial light. The *Mimosa* and the *Oxalis* so treated gave opposite results. So, too, the same plant at various times and under diverse conditions acts differently. In no other way can we account for the discrepancies in the results of experiments conducted by men of equal ability and competence. It is probable that some of these discrepancies may arise from the confounding the movements that constitute the so-called sleep of plants with those that take place in consequence of some external stimulus. This seems the more likely from a consideration of the researches recently made public by M. Paul Bert.* We regret that our space does not permit us to allude at length to M. Bert's elaborate paper, but we may, by way of conclusion,

* M. Bert's paper only reached us while this sheet was passing through the press. It is contained in the 4th volume of the *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux*, and is dated April, 1867, the title-page of the "cahier" in which the paper appears bearing the date 1866! It is one of the most important memoirs on the subject of the Sensitive plant that has yet been issued, and should be consulted by all interested in the matter.

state the result of his experiments relating to the difference between the two classes of phenomena above mentioned. After describing, with greater accuracy and detail than any previous writer, the diurnal and nocturnal movements that occur in the leaves and leaflets of the *Mimosa pudica*, and showing that they do not differ, in appearance, from those which ensue as a consequence of external stimulus, except that in the latter case the action is sudden not gradual, M. Bert proceeds to say that the causes of the phenomena are not the same in both instances. Ether arrests and prevents the movements brought about under ordinary circumstances by external stimuli, while the diurnal and nocturnal raising and lowering of the leaves are not affected by that agent. The last named actions may be induced artificially by removing the upper portion of the petiolar "coussinet," and then placing on the cut surface a drop of water; this is rapidly absorbed by the cellular tissue of the lower portion of the swelling, and the leaf-stalk becomes raised or pressed upwards in consequence. On the other hand, if a drop of glycerin be placed on the wound, the reverse action takes place and the petiole is lowered. The nocturnal movements are always caused by a slow gradual increase of force in the upper portion of the coussinet, accompanied at first by a diminished, subsequently by augmented, energy in the lower portion. The mobility that follows on excitation, on the other hand, is exclusively due to a sudden loss of energy in the lower portion of the petiolar swelling, though how this is effected remains still a mystery.

EXPLANATION OF PLATE.

FIG. 1. Leaf of *Mimosa pudica*, common Sensitive plant, expanded.
„ 2. Leaf of the same collapsed.
„ 3. Leaf of *Oxalis sensitiva*, expanded.
„ 4. Leaf of *Oxalis acetosella*, Wood-sorrel, expanded.
„ 5. Leaf of the same collapsed during "sleep."
„ 6. Transverse section of the "coussinet," or pulvinus of *Oxalis acetosella* (after Sachs).
„ 7. Leaf of *Desmodium gyrans*, Telegraph plant: *a*, the terminal leaflet; *b*, one of the lateral leaflets, which exhibits different movements from those exercised by *a*.
„ 8. Leaf of *Dionæa muscipula*, Fly-trap; the leaf-stalk is here dilated and flat, and supports a roundish blade, fringed with stiff hairs.
„ 9. Leaf of Fly-trap; the blade shown as folded in halves.
„ 10. Stamens of *Parnassia*, showing how they bend inwards towards the pistil.
„ 11. Stamens of *Parietaria* at first coiled up within the flower, but liberating themselves with an elastic movement when the pollen is ripe.
„ 12. Stamen of *Berberis*, showing the flap of the anther which springs up to liberate the pollen.

THE FORMER RANGE OF THE REINDEER IN EUROPE.

By W. BOYD DAWKINS, M.A., F.R.S., F.G.S.

THE Reindeer is the only member of the great genus Cervus fitted by nature to endure the extreme severity of an arctic winter. It thrives on the mosses that cover the great treeless spaces extending between the boundary of the woods and the great arctic sea, in Northern Europe, Asia and America, which it seems to prefer to the more tender herbage further to the south. It is found also at the extreme edge of the woods both in Asia and America, and retreats to their recesses to find some sort of shelter and food during the depth of the winter. South of its habitat lies the region of the elk and the red-deer, the exact boundary being regulated according to the season. Thus in an unusually warm summer the two latter animals advance northwards into the country of the reindeer, while in an unusually severe winter the reindeer passes southwards in search of food, as Sir John Franklin found out to his cost in his overland journey from the great arctic ocean. In this way the boundary is continually oscillating to and fro. The reindeer has been met with in the highest northern latitudes yet reached by our explorers. It abounds in Greenland and Spitzbergen, and has even crossed over on the ice to the cluster of islands off the Siberian coast, called New Siberia. In the highlands of Norway and Sweden it is also found, as well as in the loftier regions of the Urals.* Such is its present range. In past time, however, it wandered over a vast area far to the south and west of its present abode; what that range was and the causes of its modification are subjects well worthy of research, on account of the light they throw on European climate in former days. It has indeed been objected, that although climate exercises a great influence in modifying range it does not exert the only influence, and therefore that any argument from one to the other is faulty. The Bengal tiger is of the same species as that which preys on the Tartar horses on the shores of the Caspian, and on the reindeer of Eastern Asia. The fox and the wolf are also, as

* Pennant, Arctic Zoology, vol. i. p. 24.