

MR DARWIN'S NEW BOOK.

INSENSITIVE PLANTS. By Charles Darwin, M.A., F.R.S., London: John Murray, 1875.

THE charm of all Mr Darwin's work lies in the admirable skill with which he lays before the reader an overwhelming number of facts, the logical manner in which he draws conclusions therefrom, and the freedom with which he states objections, practical and theoretical, to these conclusions. In these points, his most recent work, in no respect, is an exception. Scarcely have we perused a volume in which minutes of experiments and details of observations are more carefully recorded, and where the train of reasoning by which we are led to conclusions as opposed to all preconceived ideas is so clearly set forth.

The subject, "In sensitive Plants," is one which for some years past has been prominently before the public. The discovery in 1853, by Dr Darwin Sanderson, that in the leaf of *Venus Fly-trap* (*Dionaea muscipula*) a normal electric current exists, which, upon irritation of the leaf, is distributed in a manner similar to what takes place during the contraction of muscle in animals, and the address on sensitive plants by Dr Hooker before the British Association at Belfast, have been greatly instrumental in directing public attention to the matter, so that at present the daily papers and scientific journals abound with records of the doings of these "vegetable sportsmen," as they have been happily styled. Mr Darwin now gives us the results of an investigation, extending over fifteen years, into the phenomena exhibited by these plants—results which illustrate most strikingly the laws and general powers of observation of the various philosophers. We will briefly, and as much as possible in Mr Darwin's own words, indicate one or two of the salient features of the work.

The insect-catching power of the well-known round-leaved sundew (*Dionaea muscipula*) first drew Mr Darwin's attention to this subject, and the major portion of the book is occupied with a record of investigations into the phenomena exhibited by it. But we have also an account of the insensitiveness, propounded in all the other genera of the sundew family, as well as in many plants belonging to other families,—in such plants as the liverworts (*Pinguicula*) and the bladder-worts (*Utricularia*). All are shown to be insect-catchers, not only on land but also in the water—the mechanical process differing, however, in the several genera. "All draw in animal matter by their secretion, which coheres as well together with a filament almost identical with the paper of the gastric juice in animals, and afterwards the digested matter is absorbed." In the case of *Dionaea muscipula* it is shown that a sensitive spot is located in the glands at the extremities of the tentacles which cover the upper surface of the leaf, whereby upon either direct (i.e., each gland is stimulated) or indirect (i.e., only certain glands' stimulation, whether by continued mechanical irritation, slight pressure, contact with organic or inorganic bodies, heat, &c., a motor impulse is transmitted down the tentacles by which, in periods of time varying from half a second to some hours, according to the stimulus, each tentacle bends from its base towards the centre of the leaf, and coincident with this, the glands secrete more copiously, and the secretion becomes acid. Here, then, is a new fact of great physiological importance, that an influence can be transmitted from one portion of a leaf to a gland situated at the extremity of a tentacle on another portion by which the secretion from the gland is modified. It is only recently, as Mr Darwin states, that a corresponding fact in the physiology of animals has been established. Accompanying, though not dependent on, this motion of the tentacles, a change in the contents of the cells of the tentacles is observed. "If the tentacle of a young yet fully expanded leaf that has never been excited or become indurated be examined, the cells forming the papilla are seen to be filled with homogeneous purple fluid. The walls are lined by a layer of columnar encircling protoplasm.

If a tentacle is examined some hours after the gland has been excited by repeated touches, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, it presents a wholly changed appearance. The cells, instead of being filled with a

... by the absorption or by the presence placed on it, or by the absorption of certain fluids, it presents a wholly changed appearance. The cells, instead of being filled with homogeneous purple fluid, now contain variously shaped masses of purple matter, suspended in a colorless or almost colorless fluid.

By whatever cause the process may have been excited, it commences within the glands, and then travels down the tentacles. This constitutes the phenomenon of aggregation, and its dissipation by Mr Darwin, along with the subsequent process of re-dissolution, is a matter of course (Chap. III.) The appearances in the cells after aggregation are most curious. The small masses of aggregated matter are of the most diversified shapes, and "incessantly change their form and position, being never at rest;" the layer of white granular protoplasm lies along the walls, around the aggregated masses, "at an irregular rate, up one wall and down the opposite one," sometimes rotating. This process of aggregation sometimes commences in the glands within ten seconds after stimulation—usually, however, after a longer interval—and thence travels down the pedicels. "It was interesting," continues Mr Darwin, "to observe the process momentarily arrested at each transverse partition between two cells, and then to see the transparent contents of the cell next below almost flaking into a cloudy mass." Infection of the tentacles having taken place, we are shown how they remain so for a longer or shorter period, according to the nature of the stimulus, and in this connection the important fact is proved, that they remain closed longest when organic matter, with soluble nutrient matter, is the stimulant. The tentacles slowly re-expand, and with this occurs the re-dissolution of the cell contents. "The little masses of aggregated matter are all re-dissolved, and the purple fluid becomes as homogeneous and transparent as it was at first. The process of re-dissolution travels upwards from the bases of the tentacles to the glands, therefore in a reversed direction to that of aggregation." As one reads the account of this wonderful phenomenon, one naturally speculates as to the cause and nature of the process, and the most natural explanation seems to be that it is dependent on the infection of the tentacles or the increase of the secretion of the glands, or on the absorption of additional fluid. Mr Darwin, however, shows most clearly it is independent of all these, and concludes that the process is "one of molecular change, transmitted from the glands."

Some very dexterously performed experiments show how extremely sensitive to pressure are the glands, the incredibly small portion of human hair of the 1/1000th of an inch in length, and weighing only 1/50000th of a grain, or 1/200000 milligramme, being sufficient to cause infection of the tentacle. This extreme sensitiveness of the glands to pressure, Mr Darwin points out, "is of the highest service to the plant; for if the delicate foot of a cilia is struggling in wet press even so lightly on the surface of two or three glands, the tentacles bearing these glands soon curl towards and carry the insect with them to the centre."

Around the observations on the power of dissolving, and of afterwards absorbing, solid animal matter, possessed by plants, the chief interest in the book naturally centres, and on this point we are not left in doubt; but it is most clearly proved that the leaves are capable of true digestion, and that the digested matter is absorbed. What is perhaps the most remarkable point is, that the secretion, which is poured out copiously by the glands upon stimulation, contains an acid belonging to the acetic series (probably propionic, or a mixture of acetic and butyric acids), and in addition, a ferment which is closely allied to the pepsin of the gastric juice in animals. The exact nature of the food is apparently of little moment to the plant and beyond a great desire exhibited for phosphorus, any substance containing nutritious matter is received—thus meat, cartilage, bone, enamel of teeth, &c. are

all digested, although at a different rate. Nor does the plant confine itself to animal food, but dissolves equally well the substance of seeds and pollen grains. Mr Darwin has experimented with a great number of acids, salts, alkalis, &c., with a view mainly of determining whether they have an effect similar to their effect on animals; but, as he says, a special pharmacopoeia would be necessary to describe their various, sometimes almost capricious, effects. Amongst the most remarkable, however, we note the rapid action of acids of ammonia, and also that the poison of the cobra's snake does not in the least check, but rather stimulates the spontaneous movements of the protoplasm in the cells of the tentacles. From these experiments he concludes that the plants do not include any diffused motor analogous to nerve tissue. In Chapter X., where Mr Darwin discusses the sensitiveness of the leaves, and the transmission of the motor impulse, his great power of argument and subtlety of reasoning are prominently illustrated. The sensitiveness is shown to be located only in the glands and the underlying cells. On stimulation "the motor impulse, as it spreads from two or more glands across the disc, enters the base of the surrounding tentacles, and immediately acts on the bending plane. It does not, in the first place, proceed up the tentacles to the glands, exciting them to reflect an impulse to their bases. Nevertheless an impulse is sent up to the glands, as their secretion is soon increased and rendered acid, and then the glands being thus excited send back some other influence (not dependent on increased secretion, nor on the inflection of the tentacles), causing the protoplasm to aggregate in cell beneath cell. This may be called a reflex action, though probably very different from that proceeding from the nerve-ganglion of the animal, and it is the only known case of reflex action in the vegetable kingdom." And then he continues:—"About the mechanism of the movements and the nature of the impulse we know very little. . . . But the hypothesis which agrees best with the observed facts is that the motor impulse is allied in nature to the aggregating process, and that this causes the molecules of the cell-walls to approach each other in the same manner as do the molecules of the protoplasm within the cells, so that the cell-walls contract." . . . "The re-expansion of the tentacles is largely due to the elasticity of their outer cells, which comes into play as soon as those on the inner side cease contracting with prepotent force; but we have reason to suspect that fluid is continually and slowly attracted into the outer cells during the act of re-expansion, thus increasing their tension." Having treated most exhaustively the phenomena observed in *drosera*, Mr Darwin proceeds to treat of the Venus Flytrap (*Dionaea muscipula*), which is perhaps more familiarly known as an insect-eater, the movements in the leaves being so clearly seen. This plant is quite as insectivorous as *drosera*, but the organs connected with the process are much more differentiated, and the process itself is brought about in a different manner, having a relation to the difference in habit of the plants. The sensitiveness resides here in the upright filaments, three on each lobe of the leaf, and upon stimulation motion takes place throughout the whole leaf. On the difference in the sensitiveness of these two plants Mr Darwin remarks—"A gland of *drosera* may be hit once, twice, or even thrice without any effect being produced, whilst the continued pressure of an extremely small particle excites movement. On the other hand, a particle many times heavier may be laid on one of the filaments of *dionaea* with no effect; but if touched only once by the slow movement of a delicate hair the lobe closes, and this difference in the nature of the sensitiveness of these two plants stands in manifest adaptation to their manner of capturing insects. For if a minute insect alights with its delicate feet on the glands of *drosera*, it is caught by the viscid secretion, and the slight though prolonged pressure gives notice of the presence of prey, which is secured by the slow bending of the tentacles. On the other hand, the sensitive filaments of *dionaea* are not viscid, and the capture of insects can be secured only by their sensitiveness to a momentary touch, followed by the rapid closure

present glass tubes of the diameter of 1/16, which is covered by the slow loading of the substance. On the other hand, the smaller elements of drosses are not visible, and the capture of insects can be secured only by their attachment to a necessary scale, followed by the rapid closure of the tubes. In another relation it is the fact that when the contact glands of drosses attack insects, they branch a very rapid impulse to the inferior tentacles much more quickly than when they are mechanically irritated; whilst with drosses the absorption of atmospheric matter causes the tubes to close together with extreme slowness, whilst with insects rapid movement. It is impossible to state further here than the details of this book. Let us merely call the attention of the reader to the chapter in which Mr. Darwin gives his concluding remarks on the three classes. In this chapter, by a beautiful application of the theory of drosses, the author shows with great propriety and before the general eye, by which, both insects and drosses, possess of the physiological characters, almost all classes have descended from one parent stem. Finally, in case of some recent speculations on the presence of drosses in our eyes in those plants, it is very easy to read: "The specialized nature of the sense-organs possessed by drosses and insects, and by certain other plants and drosses, may be..." "It does not appear that they include any different matter analogous to sense stems."

"Although the cells of drosses and insects are quite as sensitive to certain stimulants as are the nerves which surround the terminations of the nerves in the higher animals, yet these plants are inferior even to animals low down in the scale, in not being affected except by stimulants in contact with their sensitive parts. They would, however, probably be affected by indirect touch, for warm water causes sluggish movement. When a gland of drosses, or one of the tentacles of drosses, is excited, the motor impulses radiate in all directions, and in fact, as in the case of animals, directed towards special points or organs. The rate at which the motor impulses are transmitted, though rapid in drosses, is much slower than in most or all animals. This fact, as well as that of the motor impulses not being specially directed to certain points, are both, we think, due to the slowness of nerves. Nevertheless, we perhaps see the pre-formation of the formation of nerves in animals in the transmission of the motor impulses being so much more rapid than the contact space within the tentacles of drosses from drosses, and sometimes more rapid in a longitudinal than in a transverse direction across the tube. These plants exhibit with more plainly their inferiority to animals in the slowness of any reflex action, except in so far as the glands of drosses, when excited from a distance, send back some influence which causes the contents of the cells to become aggregated down to the base of the tentacles. But the greatest inferiority of all is the slowness of a central organ able to receive impressions from all points, to transmit their effects in any definite direction, to store them up and reproduce them."

The man who presents this book ought to be impressed with the magnitude of the work and the great scientific importance. It marks, indeed, an epoch in the history of human physiology, and opens up a wide field of research which may be looked for as a distribution of many of those problems which now occupy the minds of physiologists. Whilst wondering at the many new facts thus brought to light, we know not whether to be more astonished at the keen observation or at the scientific industry and the intellectual power of the man who has so ably elucidated them.

IMMENSURABLE PLANTS. By Charles Darwin, F.R.S., F.R.S. London: John Murray, 1872. The charm of all Mr Darwin's work lies in the absolute skill with which he lays before the reader an overwhelming number of facts, the local masses in which he draws conclusions therefrom, and the frankness with which he states objections, practical and theoretical, to these conclusions. In these points, his most recent work, is no exception. Before we perused a volume in which scientific experiments and details of observations are more carefully recorded, and where the train of reasoning by which we are led to conclusions as opposed to all preconceived ideas is so clearly set forth.

The subject, "Insensitiveness Plants," is one which for some years past has been prominently before the public. The discovery in 1853, by Dr Burdon Sanderson, that in the leaf of *Vallisneria spiralis* a normal electric current exists, which, upon irritation of the leaf, is disturbed in a manner similar to what takes place during the contraction of muscles in animals, and the address on nervousness plants by Dr Huxley before the British Association at Belfast, have been greatly instrumental in directing public attention to the matter, so that at present the daily papers and scientific journals abound with records of the doings of these "vegetable sportsmen," as they have been happily styled. Mr Darwin now gives us the result of an investigation, extending over fifteen years, into the phenomena exhibited by these plants—results which illustrate most strikingly the keen and accurate power of observation of the veteran philosopher. We will briefly, and as much as possible in Mr Darwin's own words, indicate one or two of the salient features of the work.

The insect-eating power of the well-known round-leaved sundew (*Drosera rotundifolia*) first drew Mr Darwin's attention to this subject, and the major portion of the book is occupied with a record of investigations into the phenomena exhibited by it. But we have also an account of the insensitiveness properties in all the other genera of the sundew family, as well as in many plants belonging to other families,—in such plants as the bladderwort (*Pinguicula*) and the bladderwort (*Utricularia*). All are shown to be insensitiveness, not only on land but also in the water; the mechanical process differing, however, in the several genera, "all dissolve animal matter by their secretion, which contains an acid together with a ferment almost identical with the pepsin of the gastric juice in animals, and afterwards the digested matter is absorbed." In the case of *Drosera rotundifolia* it is shown that a sensitiveness is located in the glands at the extremities of the tentacles which cover the upper surface of the leaf, whereby upon either direct (i.e., each gland is stimulated or irritated (i.e., only certain glands) stimulation, whether by continued mechanical irritation, slight pressure, contact with organic or inorganic bodies, heat, &c., a motor impulse is transmitted down the tentacle by which, in periods of time varying from ten seconds to some hours, according to the stimulus, each tentacle bends from its base towards the centre of the leaf, and coincident with this, the glands secrete more copiously, and the secretion becomes acid. Here, then, is a new kind of great physiological importance, that an influence can be transmitted from one portion of a leaf to a gland situated at the extremity of a tentacle on another portion by which the secretion from the gland is modified. It is truly recently, as Mr Darwin states, "that corresponding facts in the physiology of animals had been established. Accompanying, though not dependent on, this action of the tentacles, a change in the attitude of the cells of the tentacles is observed. "If the tentacles of a young yet fully matured leaf that has never been touched or become irritated are examined, the cells forming the papillae are seen to be filled with homogeneous granular fluid. The walls are lined by a layer of extremely irritable protoplasm. . . . If a tentacle is examined some hours after the gland has been excited by repeated touches, or by an inorganic or organic particle placed on it, or by the absorption of certain fluids, it presents a wholly changed appearance. The cells, instead of being filled with homogeneous granular fluid, now contain variously shaped masses of purple matter, surrounded by a substance of almost colorless fluid. . . . By whatever cause the process may have been excited, a continuous walk of the glands, and then rapidly down the tentacle." This constitutes the phenomenon of aggregation, and is stimulated by Mr Darwin, along with the

all digested, although at a different rate. For less the plant confines itself to animal food, but dissolves equally well the substance of seeds and pollen grains. Mr Darwin has experimented with a great number of acids, salts, alkaloids, &c., with a view mainly of determining whether they have an effect similar to their effect on animals; but, as he says, a special pharmacopoeia would be necessary to describe their various, sometimes almost surprising, effects. Amongst the most remarkable, however, we note the rapid action of salts of ammonia, and also that the poison of the cobra snake does not in the least check but rather stimulates the spontaneous movements of the protoplasm in the cells of the tentacles. From these experiments he concludes that the plants do not include any diffused matter analogous to nerve tissue. In Chapter X, where Mr Darwin discusses the sensitiveness of the leaves, and the transmission of the motor impulse, his great power of argument and sobriety of reasoning are prominently manifested. The sensitiveness is shown to be located only in the glands and the underlying cells. On stimulation "the motor impulse, as it spreads from one or more glands across the disc, enters the base of the surrounding tentacles, and immediately acts on the bending plane. It does not, in the first place, proceed up the tentacle to the glands, exciting them to collect an impulse to their base. Nevertheless an impulse is sent up to the glands, as their secretion is soon increased, and rendered acid, and then the glands being thus excited send back some other influence (not dependent on increased secretion, nor on the infection of the tentacles, namely, the protoplasm to aggregate in cell beneath cell. This may be called a reflex action, though probably very different from that proceeding from the nerve ganglia of the animal, and it is the only known case of reflex action in the vegetable kingdom." And then he continues:—"About the mechanism of the movements and the nature of the impulse we know very little. . . . But the hypothesis which agrees best with the observed facts is that the motor impulse is called in nature to the aggregating process, and that this causes the molecules of the cell-walls to approach each other in the same manner as do the molecules of the protoplasm within the cells, so that the cell-walls contract. . . . The re-expansion of the tentacles is largely due to the elasticity of their outer cells, which comes into play as soon as there is the linear side cause contracting with propellant force; but we have reason to suspect that fluid is continually and slowly attracted into the outer cells during the act of re-expansion, thus increasing their tension." Having treated most exhaustively the phenomena observed in *Drosera*, Mr Darwin proceeds to treat of the *Vallisneria spiralis* (*Drosera spiralis*), which is perhaps more familiarly known as an insect-eater; the movements in the leaves being so clearly seen. This plant is quite as insensitiveness as *Drosera*, but the organs connected with the process are much more differentiated, and the process itself is brought about in a different manner, having a relation to the difference in height of the plants. The sensitiveness resides here in the upright stems, there on each lobe of the leaf, and upon stimulation motion takes place throughout the whole leaf. On the difference in the sensitiveness of these two plants Mr Darwin remarks:—"A gland of *Drosera* may be hit once, twice, or even thrice without any effect being produced, while the continued pressure of an extremely small particle excites movement. On the other hand, a particle many times heavier may be laid on one of the stems of *Drosera* with no effect; but if touched only once by the slow movement of a delicate hair the lobe closes, and this difference in the nature of the sensitiveness of these two plants stands in clear adaptation to their manner of capturing insects. For if a sensitive touch of grass with its delicate feet on the glands of *Drosera*, it is caught by the rapid secretion, and the slight though prolonged pressure gives action of the pressure of prey, which is secured by the slow bending of the tentacles. On the other hand, the sensitive stimulus of insects are not rigid, and the capture of its own can be secured only by the sensitiveness to a secondary touch, followed by the rapid closure of the lobe." In similar relation is "The fact that when the central glands of *Drosera* absorb nitrogenous matter, they towards a motor impulse to the entire tentacles much more quickly than when they are mechanically irritated, whilst with *Drosera* the absorption of nitrogenous matter causes the lobe to press together with extreme swiftness, whilst a touch excites rapid movement." It is impossible to enter further here into the details of this book. Let us merely set the attention of the reader to the chapter in which Mr Darwin gives his concluding remarks on the *Drosera*. In this chapter, by a beautiful application of the theory of descent, the author traces out with great perspicuity and beauty the several steps by which, both through their morphological

ness, that an influence can be transmitted from one portion of a leaf to a gland situated at the extremity of a branch or another, passed by which the succulent from the gland is emitted. It is truly marvellous, as Mr Darwin states, that notwithstanding that in the physiology of animals had been established. Accompanying, though not dependent on, this motion of the tentacles, a change in the contents of the cells of the tentacles is observed. "If the tentacles of a young sea-holly are cut off, but that has never been noticed or become inflexible or stunted, the cells forming the pedicels are seen to be filled with homogeneous yellow fluid. The walls are lined by a layer of substance resembling protoplasm.

If a tentacle is examined some hours after the gland has been excited by repeated incision, or by an aqueous or organic particle placed on it, or by the absorption of certain fluids, it presents a widely changed appearance. The cells, instead of being filled with homogeneous purple fluid, now contain variously shaped masses of purple matter, suspended in a solution in almost colourless fluid.

By whatever name the process may have been called, it commences with the glands, and then spreads down the tentacles. This accounts for the phenomenon of aggregation, and its stimulation by Mr Darwin, along with the subsequent process of re-dissolution, in a matter (see Chap. III.) The appearance in the cells, after aggregation are most curious. The small masses of aggregated matter are of the most diversified shapes, and "increasingly change their form and position, being carried at last, to the layer of white granular protoplasm flows along the walls, covers the aggregated masses, "as an insular raft, up one wall and down the opposite one," sometimes tearing. This process of aggregation sometimes commences in the glands within ten seconds after stimulation—usually, however, after a longer interval—and thence travels down the pedicels. "It was interesting," continues Mr Darwin, "to observe the process, momentarily arrested at each transverse partition between two cells, and then to see the transparent contents of the cell next below almost flushing into a cloudy mass."

Infection of the tentacles having taken place, we are always here they remain so for a longer or shorter period, according to the nature of the stimulus, and in this connection the important fact is proved, that they remain closed longer when organic matter, with white vitreous matter, is the stimulus. The tentacles slowly re-expand, and with this occurs the re-dissolution of the cell contents. "The little masses of aggregated matter are all re-dissolved, and the purple fluid becomes as homogeneous and transparent as it was at first. The process of re-dissolution travels upwards from the base of the tentacles to the glands, therefore in a reversed direction to that of aggregation."

As we read the account of this wonderful phenomenon, we naturally speculate as to the cause and nature of the process, and the most natural explanation seems to be that it is dependent on the infection of the tentacles or the increase of the secretion of the glands, or on the absorption of additional fluid. Mr Darwin, however, shows most clearly it is independent of all these, and concludes that the process is "one of molecular change, transmitted from the glands."

Some very delicately performed experiments show how extremely sensitive to pressure are the glands, the incredibly small portion of human hair of the  $\frac{1}{100000}$  of an inch in length, and weighing only 1-750000th of a gram, or 200000 milligrammes, being sufficient to cause infection of the tentacles. This extreme sensitiveness of the glands to pressure, Mr Darwin points out, "is of the highest service to the plant; for if the delicate tent of a minute straggling insect presses even so lightly on the surface of two or three glands, the tentacles bearing those glands soon curl inward and carry the insect with them to the centre."

Around the observations on the power of absorbing, and of afterwards excreting, acid animal matter, generated by plants, the chief interest in the book naturally centres, and on this point we are not left in doubt; but it is most clearly proved that the leaves are capable of true digestion, and that the digested matter is absorbed. What is perhaps the most remarkable point is, that the secretion, which is generated not exclusively by the glands upon stimulation, contains an acid belonging to the acetic series (probably propionic, or a mixture of acetic and butyric acids, and in addition, a ferment which is closely allied to the pepsin of the gastric juice in animals. The exact nature of the food is apparently of little moment to the plant and beyond a great degree indistinct for phosphorus, any substance, containing vitelline matter is received—thus meat, cartilage, bones, instead of both, &c., are

and effect being produced, whilst the continued pressure of an extremely small particle excites movement. On the other hand, a particle may travel faster or may be held on one of the branches of division with no effect; but if touched only once by the slow movement of a ciliated hair the whole glows, and it is difference in the nature of the stimulation of these two glands which is made that adaptation to their manner of capturing insects. For if a minute branch of plant with its delicate feet on the glands of division, it is caught by the rapid secretion, and the slight though prolonged pressure gives notice of the presence of prey, which is secured by the slow landing of the tentacles. On the other hand, stimulative elements of division are not visible, and the capture of insects can be effected only by this stimulation in a momentary touch, followed by the rapid closure of the lobes."

In similar relation to "the fact that when the central glands of division absorb heterogeneous matter, they transmit a similar impulse to the whole tentacles much more quickly than when they are molecularly irritated, whilst with dense absorption of homogeneous matter causes the lobes to press together with extreme slowness, whilst a touch excites rapid movement." It is impossible to enter here into the details of this book. Let us merely call the attention of the reader to the chapter in which Mr Darwin gives his concluding remarks on the phenomenon. In this chapter, by a beautiful application of the theory of division, the author traces out with great perspicuity and fitness the general steps by which, both through their morphological and also physiological characters, the several genera have descended from one parent form. Finally, in view of some recent speculations on the presence of diffuse nervous tissue in these plants, it is interesting to read:—"The specialized nature of the nervous system possessed by *Utricularia* and *Volvox*, and by certain other plants well deserves attention."

"It does not appear that they include any diffused matter analogous to nerve tissue." "Although the cells of *Utricularia* and *Volvox* are quite as sensitive to certain stimulants as are the tissues which surround the terminations of the nerves in the higher animals, yet these plants are inferior even to animals low down in the scale, in not being affected except by stimulants in contact with their sensitive parts. They would, however, probably be affected by radiant heat, for warm water excites convulsive movement. When a gland of *Utricularia*, or one of the filaments of *Volvox*, is excited, the motor impulse radiates in all directions, and is not, as in the case of animals, directed towards special points or organs."

The rate at which the motor impulse is transmitted, though rapid in *Utricularia*, is much slower than in most of all animals. This fact, as well as that of the motor impulse not being specially directed to certain points, are both, we think, due to the absence of nerves. Nevertheless, we perhaps see the pre-eminence of the formation of nerves in animals in the transmission of the motor impulse being so much more rapid down the confined space within the tentacles of *Utricularia* than elsewhere, and somewhat more rapid in a longitudinal than in a transverse direction across the disk. These plants exhibit still more plainly their inferiority to animals in the absence of any reflex action, except in so far as the glands of *Utricularia*, when excited from a distance, send back some influence which causes the contents of the cells to become aggregated down to the base of the tentacles. But the greatest inferiority of all in the absence of a central organ able to receive impressions from all points, to transmit their effects in any definite direction, to store them up, and reproduce them."

No one who peruses this book can fail to be impressed with the magnitude of the work and its great scientific importance. It marks, indeed, an epoch in the history of botanical physiology, and opens up a wide field of research wherein may be looked for an elucidation of many of those problems which now occupy the minds of physiologists. Whilst wondering at the many new facts thus brought to light, we know not whether to be more astonished at the facts themselves or at the untiring industry and the intellectual power of the man who has so ably elucidated them.