reasonably be entertained that Beatrice and Laura were both women of flesh and blood, whose parentage, birth, and lives are as well known as those of the most familiar personages in history. Neither of them was a metaphysical or theological abstraction. But here the resemblance ceases; the child-love for the little girl of nine years old in the crimson frock was the glory and the purification of Dante's life; she became a part of all his philosophy and all his poetry, the root and centre and sustaining presence of it all. She pervades it all; it begins and ends with her; and the influence thus given is ever one of exaltation and virtue. The *Vita Nuova* is entirely occupied with her; in the *Convito* Dante explains the rules by which his writings are to be interpreted, and reports the story of his love, affirming that his poetry is still inspired by his recollections of her. He explains that, on losing her, he was incapable of consolation except by the study of philosophy, and in this way took place the allegorical fusion of a new mistress of his intellectual life with the old love of his youth. Then, in his great work, Beatrice is again still more elevated in position, and becomes the representative of theology and his divine guide through the regions of eternity. How different from all this is the affair of Petrarch with his Laura! Like many other of the world's great ones, Petrarch began life as a man of fashion, and it was as such, and at the age of twenty-three, that he first saw Mme. de Sade, who had then been married for a couple of years. From this time she became the object of his idolatry, and the subject of all those sonnets which, as Lord Byron has so justly observed, would probably never have been written if she had been his wife. But it was the fashion to have an ideal or mythical mistress, and the man of letters delighted himself, while he also made himself intensely miserable, by endless outpourings of affected grief and never-ceasing agonies of unrewarded attachment. As Mr. Henry Reeve has remarked, it is clear that his tenderness, even if real, was sustained by the pleasure it gave him to transfuse it into well-turned verse. Foscolo had previously seen that the love of Petrarch for Laura was, in truth, not of an ennobling character, and that it was in effect a contest of unworthy desires with continuing and justly deserved disappointment, colouring his existence with morbid feelings, and leading to nothing great or good, beyond being the pivot on which some of the finest, but also some of the most artificial, poetry that was ever written is made to turn.

One of Klaczko's speakers is made to call Petrarch the first man of modern times; but one of the excuses for adopting a conversational form in writing is the license it affords to say that for which the author does not wish to make himself altogether responsible. Foremost Petrarch certainly was in his own field and in his own time, and vastly is the world of letters indebted to him for the work performed by him in the redintegration of ancient literature. It is to be regretted that no selection has ever been made and published from Petrarch's letters, now so well edited and in course of translation into Italian, and to be obtained in a more convenient form than the bulky old folios of Basle and Venice. Their Latin is the nervous and playful language of a man to whom it was still a living tongue in daily use, and they can only be matched for interest and animation with those of Cicero. M. Klaczko compares the familiar correspondence of Petrarch to that of Voltaire, and notes that the enormous influence exercised by him on his contemporaries can only be appreciated by making acquaintance with it.

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In the third and fourth sections of the *Causeries Florentines* are more particularly discussed the relations of Dante with the Catholic Church and the political bearings of his actual career and his writings. Rossetti's strangely perverted views are combated, and the poet is shown to be, what he in fact was, a thoroughly orthodox son of the Church, giving to it as entire a loyalty in spiritual matters as he contended should be given to the Emperor of his idea in matters of purely temporal government. He was neither a Manfred nor a Faust, but an eminently conservative thinker and worker, so far as the broken opportunities of his distracted life allowed him to be a practical worker in the politics of his time. His grand ideal of one Empire and one Church could scarcely have been brought into the domain of reality under any circumstances of favourable action; nor was his personal temperament of a kind to make him a successful leader or associate of men engaged in forwarding a great political movement.

M. Klaczko cites Milton and Klopstock as two Protestant poets who have chosen sacred subjects as their themes—names which should not be placed together, except when under the bracket of their common Protestantism; but the *Messiah* of the latter does not meet with much favour at the hands of the assembled guests at the Florentine villa; and the advantage enjoyed by Dante, as a fervent Catholic, in carrying on his poem to the sublimest joys of Paradise, is justly contrasted with Milton's comparative failure in his *Paradise Lost*. The well-known lines from the Sixth Æneid are quoted to show that the ancients had a purgatory of their own; and Witte's theory of the unity of the so-called Trilogy of Dante is discussed—a theory to which we have already indicated entire adhesion, but which M. Klaczko is inclined apparently to dispute, and not now for the first time. The *New Life*, the *Banquet*, and the *Divine Comedy* form unquestionably parts of one whole conception, and cannot indeed be thoroughly understood if read apart from each other.

DARWIN'S POWER OF MOVEMENT IN PLANTS.*

MR. DARWIN'S latest study of plant life shows no abatement of his power of work or his habits of fresh and original observation. We have learnt to expect from him at intervals, never much prolonged, the results of special research in some bypath or other subordinated to the main course of the biological system associated with his name; and it has been an unfailing source of interest to see the central ideas of the evolution and the continuity of life developed in detail through a series of special treatises, each well nigh exhaustive of the materials available for its subject. It is in the department of plant life that he has of late years devoted himself to working out the laws which govern the whole realm of vital phenomena. That these laws in their origin and ultimate operation are common to plant and animal alike has long formed a characteristic principle or axiom of his philosophy. In the experimental study needed for the elaboration of the vital processes and the making good the resulting generalizations, the kingdom of plant life offers decided advantages beyond that of animals, if it were only that observations of this class are free from all possible taint of inhumanity. Mr. Darwin has in the quietude of his hothouse, and with a boundless variety of forms for selection, experimented upon the vital organism of plants, seconded by the untiring energy and patience of his son. Night and day seem to have come alike to the aid of this enthusiastic pair of naturalists. The electric light has served them on the failure of the sun's beams, and has in truth opened up of itself a wholly new field for observation as regards the agency of light upon the phenomena of life. To the vista of knowledge revealed by these experiments upon the elementary processes of life in movement, growth, nutrition, respiration, sensation, and so forth, imagination can set no bounds. It is impossible, Mr. Darwin remarks at the close of his record of these interesting experiments, not to be struck with the resemblance between the foregoing movements of plants and many of the actions performed unconsciously by the lower animals. This analogy has been made the subject of much interesting investigation by Sachs, Frank, and other leading biologists on the Continent, and we may expect that the highly original and elaborate experiments recorded in the volume before us will give fresh stimulus to this most important course of investigation, laying as they do a new and more solid basis for the comparative study of plant and animal life. Plants, of course, possess neither nerves nor a central nervous system, and there is consequently lacking in them that which gives its most distinctive character to animal life as a whole. Yet that sensitive impressions are present in plants, with the power of movement in obedience to the stimulus thereby imparted to the organism, may be held to be conclusively shown by facts such as those produced by Mr. Darwin. Most striking of all, he urges, as a point of resemblance, is the localization of their sensitiveness, and the transmission of an influence from the excited part to another, which consequently moves. May it not be inferred that in animals the nervous structures serve merely for the more perfect transmission of impressions and for the more complete intercommunication of parts? From the earliest sign of germination in plants—namely, the protrusion of the radicle from the seed-coats under the soil—there is manifest a sensitiveness to external influences, with a movement in response to the conditions of light or pressure, and so forth, which is not sharply to be distinguished from the rudimentary intelligence in animals. In the sensitive point or tip of the radicle, which we might compare with the antennæ in insects, there is to be seen an organic power equivalent, in a lesser degree, to the action of the brain in the lower animals:—

> We believe that there is no structure in plants more wonderful, as far as its functions are concerned, than the tip of the radicle. If the tip be lightly pressed or burnt or cut, it transmits an influence to the upper adjoining part, causing it to bend away from the affected side; and, what is more surprising, the tip can distinguish between a slightly harder and softer object, by which it is simultaneously pressed on opposite sides. If, however, the radicle is pressed by a similar object a little above the tip, the pressed part does not transmit any influence to the more distant parts, but bends abruptly towards the object. If the tip perceives the air to be moister on one side than on the other, it likewise transmits an influence to the upper adjoining part, which bends towards the source of moisture. When the tip is excited by light (though in the case of radicles this was ascertained in only a single instance) the adjoining part bends from the light; but when excited by gravitation the same part bends towards the centre of gravity. In almost every case we can clearly perceive the final purpose or advantage of the several movements. Two, or perhaps more, of the exciting causes often act simultaneously on the tip, and one conquers the other, no doubt in accordance with its importance for the life of the plant. The course pursued by the radicle in penetrating the ground must be determined by the tip; hence it has acquired such diverse kinds of sensitiveness. It is hardly an exaggeration to say that the tip of the radicle thus endowed, and having the power of directing the movements of the adjoin-

* *The Power of Movement in Plants.* By Charles Darwin, LL.D., F.R.S., assisted by Francis Darwin. With Illustrations. London: Murray, 1880.

ing parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements.

In this suggestive passage, with which our authors bring their present course of investigations to a close, we see opened up a far-reaching prospect for the biological progress of the future. For the present it must suffice to have made good so much as our authors have been able to report from their patient study of the simpler and more easily observable vital phenomena. There has always been something mystericus in the power of movement to be noted in plants, whether periodical or incidental. An astonishingly small stimulus is found to be enough in most cases, and the difficulty with our authors lay in devising means of sufficient delicacy to appreciate or to measure the degree of motion. Even in the case of allied plants, one may be found highly sensitive to the slightest continuous pressure, another as responsive to a slight momentary touch. The most widely prevalent movement is essentially of the same nature as that of a climbing plant, which bends in succession to all points of the compass, hence named "circumnutation." Instead, however, of simply revolving on an axis, the plant-stem is growing at the same time, and its apex consequently tends to describe a circular spiral, or irregular ellipse. At times the apex travels backwards in a zig-zag line, or makes small subordinate loops or triangles. Until recently the cause of all such bending movements was sought for in increased growth on the side which becomes for a time convex; but the experiments of Sachs and De Vries have led to the conclusion that this cause is but secondary, the movement of circumnutation being primarily due to the increased turgescence of the cells on either side, together with the extensibility of their walls. On however small a scale, every growing part of every plant is continually circumnutating, as the whole volume before us tends to show. Even the stems of seedlings, before they have broken through the ground, as well as their buried radicles, circumnutate to the extent allowed by the pressure of the earth:—

> In this universally present movement we have the basis or groundwork for the acquirement, according to the requirements of the plant, of the most diversified movements. Thus, the great sweeps made by the stems of twining plants, and by the tendrils of other climbers, result from a mere increase in the amplitude of the ordinary movement of circumnutation. The position which young leaves and other organs ultimately assume is acquired by the circumnutating movement being increased in some one direction. The leaves of various plants are said to sleep at night, and it will be seen that their blades then assume a vertical position through modified circumnutation, in order to protect their upper surfaces from being chilled through radiation. The movements of various organs to the light, which are so general throughout the vegetable kingdom, and occasionally from the light, or transversely with respect to it, are all modified forms of circumnutation; as again are the equally prevalent movements of stems, &c., towards the zenith, and of roots towards the centre of the earth. In accordance with these conclusions, a considerable difficulty in the way of evolution is in part removed, for it might have been asked, how did all their diversified movements for the most different purposes first arise? As the case stands, we know that there is always movement in progress, and its amplitude, or direction, or both, have only to be modified for the good of the plant in relation with internal or external stimuli.

A great part of Mr. Darwin's work is taken up with the details of experiments for measuring the quantity and direction of motion in plants, both under natural and artificial conditions. Direct observations have been made in numerous cases under the microscope, and in others use has been made of delicate apparatus of various kinds. Minute bits of card or tissue paper have been attached to the radicles, filaments, or terminals of stems, and tiny particles of metal or beads of shellac have been employed as weights to test the power of rigidity or of sensitiveness in the fibres of plants. Pins stuck in the soil around the stem have served to mark the conduct of the plant when impeded in its growth or its spontaneous habits of movement. The movements of the tenderest filaments or leaflets have been made to trace themselves in lines upon smoked glass. A series of diagrams has in this way been worked out, and set before the eye in numerous woodcuts, generally magnified two or three fold, showing the general law of circumnutation indefinitely modified by special conditions. The differences of movement in seedling and mature plants, in monocotyledons and dicotyledons, with the indications of certain movements having been acquired for a special purpose, are pursued through widely contrasted classes of plants. The circumnutating powers of young leaves are described in thirty-three genera belonging to twenty-five families, widely distributed amongst ordinary and gymnospermous dicotyledons, and amongst monocotyledons, together with many cryptogams. Here the seat of movement is generally seen to lie in the petiole, but sometimes both in the petiole and the blade, or in the blade alone. The movement is chiefly in a vertical plane; yet, as the ascending and descending lines never coincide, there is always some lateral movement, resulting in irregular ellipses, so that the motion becomes really one of circumnutation. It is interesting to mark the periodicity of leaf-movement, a gentle rise being observed in the evening and the early part of the night, with a sinking towards morning. In Dionœa and certain graminiæ a strange jerking and oscillatory movement is to be seen under the microscope, curiously contrasted with the immobility of the tentacles of Drosera rotundifolia, which are yet sensitive enough to curl inwards in twenty-three seconds so as to absorb a bit of raw meat. The distinction of epinastic and hyponastic growth—according as the growth takes place more rapidly in the upper or lower surface of an organ, causing it to bend downwards or upwards respectively—introduced by De Vries, has been illustrated in the case of a number of plants. To Frank is due the introduction of the useful terms of "heliotropism," for the tendency to turn to the light, with its correlative "apheliotropism," the opposite tendency, occasionally to be observed, "geotropism," for the bending towards the earth, and "apogeotropism," expressing motion in opposition to gravity or from the centre of the earth. For the measurement of movements, sometimes excessively minute, various expedients were adopted. Dots were made from time to time upon sheets of glass placed vertically and horizontally near the plant, these dots being then copied on tracing paper and joined by ruled lines, arrows being added to show the direction of the movement. The plants were exposed to varied conditions of light, sometimes being wholly protected, the light at other times being admitted from above or from either side. In addition to the sun's rays, the electric light was made the subject of experiment, with results comparable with those of Dr. Siemens. A valuable chapter is given to the sensitiveness of plants to light, with its transmitted effects. That growth in general is checked by light, which acts upon plants much in the same manner as it does upon the nervous system in animals, is a statement which needs to be reconciled with the undoubted fact that the power of bending to the light is beneficial to plants, and may in all probability have been specially acquired under the action of natural selection. Experiments have abundantly shown that growth is exceptionally promoted by light continuously kept up, as in the Polar summer, or when the absence of sunlight is compensated by the electric ray. Herein is, of course, involved the intricate problem of the sleep of plants, which is carried on through two chapters of the highest interest.

What is called the sleep of plants, which was observed as early as the time of Pliny, and was brought under scientific discussion by the famous *Somnus Plantarum* of Linnæus, presents hardly any analogy, as our authors are careful to premise, to the sleep of animals. This is doubtless owing to the absence in plants of a cerebral or nervous system, which needs to recruit its powers by periodical repose. The term "nyctitropism" is to be preferred for the so-called sleep-movements of plants. As a result of very numerous and varied experiments, it is to be inferred that in these movements we see the general principle of circumnutation modified by the alternations of day and night, or, strictly speaking, of light and darkness. That they are to a certain extent inherited seems to be shown by most plants habitually resuming their proper diurnal position in the morning, although light be excluded; as well as by their leaves continuing to move in the normal manner in darkness for a day or so at least. A long list of all the genera known to include sleeping plants is given in Chapter VII., differing in some respects from that of Linnæus. The nyctitropic movements of leaves and cotyledons, which are distinguished with great minuteness, are effected in two ways; first, by means of the pulvini (cushions or joints) becoming, as Pfeffer has shown, alternately more turgescent on opposite sides; and, secondly, by increased growth along one side of the petiole or mid-rib, and then on the opposite side, as was first proved by Batalin. These movements often range through an angle of 90°, being more rapid in the evening, the cotyledons in some cases moving vertically upwards at night, while the leaflets move vertically downwards. The advantage resulting from such changes of position is shown to be the protection of the upper surface from being chilled by radiation, experiments proving the ill effects produced when leaves were pinned down so as to be unable to assume their natural nyctitropic position. The same purpose is seen to be subserved by the imbrication of sleeping plants for mutual protection—a very common phenomenon. The mere closing of the petals of flowers at the close of the day, it is to be observed, does not come under the head of sleep. It is due, our authors believe, rather to the fall of temperature than to the failure of light. In their remarks upon the movements excited by light, note is taken of the difference first pointed out by Sachs between the action of light in modifying the periodic movement of leaves, and in causing them to bend towards its source—the latter, or heliotropic, movements being determined by the direction of the light, whilst the periodic movements are affected by changes in its intensity, not in its direction. The phenomenon of apheliotropism, or negative heliotropism, when a plant unequally illuminated on the two sides bends from the light, is comparatively rare, our authors only having observed it in the cases of Bignonia capreolata and Cyclamen Persicum. Among the extremely few plants which show no trace of heliotropism they mention Drosera rotundifolia and Dionœa. The pitchers of Sarracenia have also been found by Sir Joseph Hooker insensible to a long-continued lateral light. There can be no doubt that the primary and ruling agency in all plant movements is that of light. We look forward with deep interest to the prosecution of researches which may penetrate still further in this direction.

THE GRANDIDIERS.*

THE GRANDIDIERS, although it bears a French name, is an exceedingly favourable specimen of a German novel. There is none of the tediousness, of the looseness of plot and vague inconsistency of purpose, which too often annoy us in these productions, and yet there is no lack of the realistic pictures of society in which the German novelists excel. Herr Rodenberg tells his

* *The Grandidiers: a Tale of Berlin Life.* By Julius Rodenberg. From the German by William Savile. London: Sampson Low & Co.

reasonably be entertained that Beatrice and Laura were both women of flesh and blood, whose parentage, birth, and lives are as well known as those of the most familiar personages in history. Neither of them was a metaphysical or theological abstraction. But here the resemblance ceases; the child-love for the little girl of nine years old in the crimson frock was the glory and the purification of Dante's life; she became a part of all his philosophy and all his poetry, the root and centre and sustaining presence of it all. She pervades it all; it begins and ends with her; and the influence thus given is ever one of exaltation and virtue. The *Vita Nuova* is entirely occupied with her; in the *Convito* Dante explains the rules by which his writings are to be interpreted, and reports the story of his love, affirming that his poetry is still inspired by his recollections of her. He explains that, on losing her, he was incapable of consolation except by the study of philosophy, and in this way took place the allegorical fusion of a new mistress of his intellectual life with the old love of his youth. Then, in his great work, Beatrice is again still more elevated in position, and becomes the representative of theology and his divine guide through the regions of eternity. How different from all this is the affair of Petrarch with his Laura! Like many other of the world's great ones, Petrarch began life as a man of fashion, and it was as such, and at the age of twenty-three, that he first saw Mme. de Sade, who had then been married for a couple of years. From this time she became the object of his idolatry, and the subject of all those sonnets which, as Lord Byron has so justly observed, would probably never have been written if she had been his wife. But it was the fashion to have an ideal or mythical mistress, and the man of letters delighted himself, while he also made himself intensely miserable, by endless outpourings of affected grief and never-ceasing agonies of unrewarded attachment. As Mr. Henry Reeve has remarked, it is clear that his tenderness, even if real, was sustained by the pleasure it gave him to transfuse it into well-turned verse. Foscolo had previously seen that the love of Petrarch for Laura was, in truth, not of an ennobling character, and that it was in effect a contest of unworthy desires with continuing and justly deserved disappointment, colouring his existence with morbid feelings, and leading to nothing great or good, beyond being the pivot on which some of the finest, but also some of the most artificial, poetry that was ever written is made to turn.

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DARWIN'S POWER OF MOVEMENT IN PLANTS.*

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* *The Power of Movement in Plants.* By Charles Darwin, LL.D., F.R.S., assisted by Francis Darwin. With Illustrations. London: Murray. 1880.

ing parts, acts like the brain of one of the lower animals; the brain being seated within the anterior end of the body, receiving impressions from the sense-organs, and directing the several movements.

In this suggestive passage, with which our authors bring their present course of investigations to a close, we see opened up a far-reaching prospect for the biological progress of the future. For the present it must suffice to have made good so much as our authors have been able to report from their patient study of the simpler and more easily observable vital phenomena. There has always been something mysterious in the power of movement to be noted in plants, whether periodical or incidental. An astonishingly small stimulus is found to be enough in most cases, and the difficulty with our authors lay in devising means of sufficient delicacy to appreciate or to measure the degree of motion. Even in the case of allied plants, one may be found highly sensitive to the slightest continuous pressure, another as responsive to a slight momentary touch. The most widely prevalent movement is essentially of the same nature as that of a climbing plant, which bends in succession to all points of the compass, hence named "circumnutation." Instead, however, of simply revolving on an axis, the plant-stem is growing at the same time, and its apex consequently tends to describe a circular spiral, or irregular ellipse. At times the apex travels backwards in a zig-zag line, or makes small subordinate loops or triangles. Until recently the cause of all such bending movements was sought for in increased growth on the side which becomes for a time convex; but the experiments of Sachs and De Vries have led to the conclusion that this cause is but secondary, the movement of circumnutation being primarily due to the increased turgescence of the cells on either side, together with the extensibility of their walls. On however small a scale, every growing part of every plant is continually circumnutating, as the whole volume before us tends to show. Even the stems of seedlings, before they have broken through the ground, as well as their buried radicles, circumnutate to the extent allowed by the pressure of the earth:—

> In this universally present movement we have the basis or groundwork for the acquirement, according to the requirements of the plant, of the most diversified movements. Thus, the great sweeps made by the stems of twining plants, and by the tendrils of other climbers, result from a mere increase in the amplitude of the ordinary movement of circumnutation. The position which young leaves and other organs ultimately assume is acquired by the circumnutating movement being increased in some one direction. The leaves of various plants are said to sleep at night, and it will be seen that their blades then assume a vertical position through modified circumnutation, in order to protect their upper surfaces from being chilled through radiation. The movements of various organs to the light, which are so general throughout the vegetable kingdom, and occasionally from the light, or transversely with respect to it, are all modified forms of circumnutation; as again are the equally prevalent movements of stems, &c., towards the zenith, and of roots towards the centre of the earth. In accordance with these conclusions, a considerable difficulty in the way of evolution is in part removed, for it might have been asked, how did all their diversified movements for the most different purposes first arise? As the case stands, we know that there is always movement in progress, and its amplitude, or direction, or both, have only to be modified for the good of the plant in relation with internal or external stimuli.

A great part of Mr. Darwin's work is taken up with the details of experiments for measuring the quantity and direction of motion in plants, both under natural and artificial conditions. Direct observations have been made in numerous cases under the microscope, and in others use has been made of delicate apparatus of various kinds. Minute bits of card or tissue paper have been attached to the radicles, filaments, or terminals of stems, and tiny particles of metal or beads of shellac have been employed as weights to test the power of rigidity or of sensitiveness in the fibres of plants. Pins stuck in the soil around the stem have served to mark the conduct of the plant when impeded in its growth or its spontaneous habits of movement. The movements of the tenderest filaments or leaflets have been made to trace themselves in lines upon smoked glass. A series of diagrams has in this way been worked out, and set before the eye in numerous woodcuts, generally magnified two or three fold, showing the general law of circumnutation indefinitely modified by special conditions. The differences of movement in seedling and mature plants, in monocotyledons and dicotyledons, with the indications of certain movements having been acquired for a special purpose, are pursued through widely contrasted classes of plants. The circumnutating powers of young leaves are described in thirty-three genera belonging to twenty-five families, widely distributed amongst ordinary and gymnospermous dicotyledons, and amongst monocotyledons, together with many cryptogams. Here the seat of movement is generally seen to lie in the petiole, but sometimes both in the petiole and the blade, or in the blade alone. The movement is chiefly in a vertical plane; yet, as the ascending and descending lines never coincide, there is always some lateral movement, resulting in irregular ellipses, so that the motion becomes really one of circumnutation. It is interesting to mark the periodicity of leaf-movement, a gentle rise being observed in the evening and the early part of the night, with a sinking towards morning. In Dioncea and certain graminiæ a strange jerking and oscillatory movement is to be seen under the microscope, curiously contrasted with the immobility of the tentacles of Drosera rotundifolia, which are yet sensitive enough to curl inwards in twenty-three seconds so as to absorb a bit of raw meat. The distinction of epinastic and hyponastic growth—according as the growth takes place more rapidly in the upper or lower surface of an organ, causing it to bend downwards or upwards respectively—introduced by De Vries, has been illustrated in the case of a number of plants. To Frank is due the introduction of the useful terms of "heliotropism," for the tendency to turn to the light, with its correlative "apheliotropism," the opposite tendency, occasionally to be observed, "geotropism," for the bending towards the earth, and "apogeotropism," expressing motion in opposition to gravity or from the centre of the earth. For the measurement of movements, sometimes excessively minute, various expedients were adopted. Dots were made from time to time upon sheets of glass placed vertically and horizontally near the plant, these dots being then copied on tracing paper and joined by ruled lines, arrows being added to show the direction of the movement. The plants were exposed to varied conditions of light, sometimes being wholly protected, the light at other times being admitted from above or from either side. In addition to the sun's rays, the electric light was made the subject of experiment, with results comparable with those of Dr. Siemens. A valuable chapter is given to the sensitiveness of plants to light, with its transmitted effects. That growth in general is checked by light, which acts upon plants much in the same manner as it does upon the nervous system in animals, is a statement which needs to be reconciled with the undoubted fact that the power of bending to the light is beneficial to plants, and may in all probability have been specially acquired under the action of natural selection. Experiments have abundantly shown that growth is exceptionally promoted by light continuously kept up, as in the Polar summer, or when the absence of sunlight is compensated by the electric ray. Herein is, of course, involved the intricate problem of the sleep of plants, which is carried on through two chapters of the highest interest.

What is called the sleep of plants, which was observed as early as the time of Pliny, and was brought under scientific discussion by the famous *Somnus Plantarum* of Linnæus, presents hardly any analogy, as our authors are careful to premise, to the sleep of animals. This is doubtless owing to the absence in plants of a cerebral or nervous system, which needs to recruit its powers by periodical repose. The term "nyctitropism" is to be preferred for the so-called sleep-movements of plants. As a result of very numerous and varied experiments, it is to be inferred that in these movements we see the general principle of circumnutation modified by the alternations of day and night, or, strictly speaking, of light and darkness. That they are to a certain extent inherited seems to be shown by most plants habitually resuming their proper diurnal position in the morning, although light be excluded; as well as by their leaves continuing to move in the normal manner in darkness for a day or so at least. A long list of all the genera known to include sleeping plants is given in Chapter VII., differing in some respects from that of Linnæus. The nyctitropic movements of leaves and cotyledons, which are distinguished with great minuteness, are effected in two ways; first, by means of the pulvini (cushions or joints) becoming, as Pfeffer has shown, alternately more turgescent on opposite sides; and, secondly, by increased growth along one side of the petiole or mid-rib, and then on the opposite side, as was first proved by Batalin. These movements often range through an angle of 90°, being more rapid in the evening, the cotyledons in some cases moving vertically upwards at night, while the leaflets move vertically downwards. The advantage resulting from such changes of position is shown to be the protection of the upper surface from being chilled by radiation, experiments proving the ill effects produced when leaves were pinned down so as to be unable to assume their natural nyctitropic position. The same purpose is seen to be subserved by the imbrication of sleeping plants for mutual protection—a very common phenomenon. The mere closing of the petals of flowers at the close of the day, it is to be observed, does not come under the head of sleep. It is due, our authors believe, rather to the fall of temperature than to the failure of light. In their remarks upon the movements excited by light, note is taken of the difference first pointed out by Sachs between the action of light in modifying the periodic movement of leaves, and in causing them to bend towards its source—the latter, or heliotropic, movements being determined by the direction of the light, whilst the periodic movements are affected by changes in its intensity, not in its direction. The phenomenon of apheliotropism, or negative heliotropism, when a plant unequally illuminated on the two sides bends from the light, is comparatively rare, our authors only having observed it in the cases of Bignonia capreolata and Cyclamen Persicum. Among the extremely few plants which show no trace of heliotropism they mention Drosera rotundifolia and Dioncæa. The pitchers of Sarracenia have also been found by Sir Joseph Hooker insensible to a long-continued lateral light. There can be no doubt that the primary and ruling agency in all plant movements is that of light. We look forward with deep interest to the prosecution of researches which may penetrate still further in this direction.

THE GRANDIDIERS.*

THE GRANDIDIERS, although it bears a French name, is an exceedingly favourable specimen of a German novel. There is none of the tediousness, of the looseness of plot and vague inconsistency of purpose, which too often annoy us in these productions, and yet there is no lack of the realistic pictures of society in which the German novelists excel. Herr Rodenberg tells his

* *The Grandidiers: a Tale of Berlin Life.* By Julius Rodenberg. From the German by William Savile. London: Sampson Low & Co.