DARWIN'S INSECTIVOROUS AND CLIMBING PLANTS.*

"MINERALS grow: vegetables grow and live; animals grow, live, and feel;" this is the well-worn, not to say out-worn, diagnosis of the three kingdoms by Linnæus. It must be said of it, that the agreement indicated in the first couplet is unreal, and that the distinction declared in the second is evanescent. Crystals do not grow at all in the sense that plants and animals grow. On the other hand, if a response to external impressions by special movements is evidence of feeling, vegetables share this endowment with animals, while, if conscious feeling is meant, this can be affirmed only of the higher animals. What appears to remain true is, that the difference is one of successive addition. That the increment in the organic world is of many steps; that in the long series no absolute lines separate, or have always separated, organisms which barely respond to impressions from those which more actively and variously respond, and even from those that consciously so respond—this, as we all know, is what the author of the works before us has undertaken to demonstrate. Without reference here either to that part of the series with which man is connected, and in some sense or other forms a part of, or to that lower *limbo* where the two organic kingdoms apparently merge—or whence, in evolutionary phrase, they have emerged—Mr. Darwin, in the present volumes, directs our attention to the behavior of the highest plants alone. He shows that some (and he might add that all) of them execute movements for their own advantage, and that some capture and digest living prey. When plants are seen to move and to devour, what faculties are left that are distinctively animal?

As to insectivorous or otherwise carnivorous plants, we have so recently here discussed this subject—before it attained to all this new popularity—that a brief account of Mr. Darwin's investigation may suffice.† It is full of interest as a physiological research, and is a model of its kind, as well for the simplicity and directness of the means employed as for the clearness with which the results are brought out—results which any one may verify now that the way to them is pointed out, and which, surprising as they are, lose half their wonder in the ease and sureness with which they seem to have been reached.

Rather more than half the volume is devoted to one subject, the round-leaved Sundew (*Drosera rotundifolia*), a rather common plant in the northern temperate zone. That flies stick fast to its leaves, being limed by the tenacious seeming dew drops which stud its upper face and margins, had long been noticed in Europe and in this country. We have heard hunters and explorers in our northern woods refer with satisfaction to the fate which in this way often befalls one of their plagues, the black fly of early summer. And it was known to some observant botanists in the last century, although forgotten or discredited in this, that an insect caught on the viscid glands it has happened to alight upon is soon fixed by many more—not merely in consequence of its struggles, but by the spontaneous incurvation of the stalks of surrounding and untouched glands; and even the body of the leaf had been observed to incurve or become cup-shaped so as partly to involve the captive insect.

Mr. Darwin's peculiar investigations not only confirm all this, but add greater wonders. They relate to the sensitiveness of these *tentacles*, as he prefers to call them, and the mode in which it is manifested; their power of absorption; their astonishing discernment of the presence of animal or other soluble azotized matter, even in quantities so minute as to rival the spectroscope—that most exquisite instrument of modern research—in delicacy; and, finally, they establish the fact of a true digestion, in all essential respects similar to that of the stomach of animals.

First as to sensitiveness and movement. Sensitiveness is manifested by movement or change of form in response to an external impression. The sensitiveness in the Sundew is all in the gland which surmounts the tentacle. To incite movement or other action, it is necessary that the gland itself should be reached. Anything laid on the surface of the viscid drop, the spherule of clear glairy liquid which it secretes, produces no effect unless it sinks through to the gland; or unless the substance is soluble and reaches it in solution, which, in the case of certain substances, has the same effect. But the glands themselves do not move, nor does any neighboring portion of the tentacle. The outer and longer tentacles bend inward (toward the centre of the leaf) promptly when the gland is irritated or stimulated, sweeping through an arc of 180° or less, or more—the quickness and the extent of the inflection depending, in equally vigorous leaves, upon the amount of irritation or stimulation, and also upon its kind. A tentacle with a particle of raw meat on its gland sometimes visibly begins to bend in ten seconds, becomes strongly incurved in five minutes, and its tip reaches the centre of the leaf in half an hour; but this is a case of extreme rapidity. A particle of cinder, chalk, or sand will also incite the bending if actually brought in contact with the gland, not merely resting on the drop; but the inflection is then much less pronounced and more transient. Even a bit of thin human hair, only 1-8,000th of an inch in length, weighing only the 1-78,740th of a grain, and largely supported by the viscid secretion, suffices to induce movement; but, on the other hand, one or two momentary, although rude, touches with a hard object produce no effect, although a repeated touch or the slightest pressure, such as that of a gnat's foot, prolonged for a short time causes bending. The seat of the movement is wholly or nearly confined to a portion of the lower part of the tentacle, above the base, where no local irritation produces the slightest effect. The movement takes place only in response to some impression made upon its own gland at the distant extremity, or upon other glands far more remote. For if one of these members suffers irritation the others sympathize with it. Very noteworthy is the correlation between the central tentacles, upon which an insect is most likely to alight, and these external and larger ones, which in proportion to their distance from the centre take the larger share in the movement. The shorter central ones do not move at all when a bit of meat or a crushed fly or a particle of a salt of ammonia or the like is placed upon them; but they transmit their excitation across the leaf to the surrounding tentacles on all sides; and they, although absolutely untouched, as they successively receive the mysterious impulse, bend strongly inward, just as they do when their own glands are excited. Whenever a tentacle bends in obedience to an impulse from its own gland, the movement is always toward the centre of the leaf; and this also takes place, as we have seen, when an exciting object is lodged at the centre. But when the object is placed upon either half of the leaf, the impulse radiating from thence causes all the surrounding untouched tentacles to bend with precision toward the point of excitement, even the central tentacles, which are motionless when themselves charged, now responding to the call. The inflection which follows mechanical irritation or the presence of any inorganic or insoluble body is transient; that which follows the application of organic matter lasts longer, more or less, according to its nature and the amount; but sooner or later the tentacles resume their former position, their glands glisten anew with fresh secretion, and they are ready to act again.

As to how the impulse is originated and propagated, and how the movements are made, comparatively simple as the structure is, we know as little as we do of the nature of nervous impulse and muscular motion. But two things Mr. Darwin has well-nigh made out, both of them by means and observations so simple and direct as to command our confidence, although they are contrary to the prevalent teaching. First, the transmission is through the ordinary cellular tissue, and not through what are called the fibrous or vascular bundles. Second, the movement is a vital one, and is effected by contraction on the side towards which the bending takes place, rather than by turgescent tension of the opposite side. The tentacle is pulled over rather than pushed over. So far it accords with muscular action.

The operation of this fly-catching apparatus, in any case, is plain. If the insect alights upon the disc of the leaf, the viscid secretion holds it fast—at least an ordinary fly is unable to escape—its struggles only increase the number of glands involved and the amount of excitement; this is telegraphed to the surrounding and successively longer tentacles, which bend over in succession, so that within ten to thirty hours, if the leaf is active and the fly large enough, every one of the glands (on the average, nearly two hundred in number) will be found applied to the body of the insect. If the insect is small and the lodgment towards one side, only the neighboring tentacles may take part in the capture. If two or three of the strong marginal tentacles are first encountered, their prompt inflection carries the intruder to the centre, and presses it down upon the glands which thickly pave the floor; these notify all the surrounding tentacles of the capture, that they may share the spoil, and the fate of that victim is even as of the first. A bit of meat or a crushed insect is treated in the same way.

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* Insectivorous Plants. By Charles Darwin, M.A., F.R.S.' With Illustrations. London: John Murray. 1875. Pp. 461. New York: D. Appleton & Co.

† The Movements and Habits of Climbing Plants. By Charles Darwin, M.A., F.R.S., etc.' Second Edition, revised, with Illustrations. London: John Murray. 1875. Pp. 192. New York: D. Appleton & Co.

‡ The *Nation*, Nos. 457, 458, 1874. It was in these somewhat light and desultory, but substantially serious, articles that some account of Mr. Darwin's observations upon the digestive powers of *Drosera* and *Dionæa* first appeared; in fact, the leading motive was to make sufficient reference to his then unpublished discoveries to guard against expected or possible claims to priority. Dr. Burdon-Sanderson's lecture, and the report in *Nature*, which first made them known in England, appeared later.

A mistake on our part in the reading of a somewhat ambiguous sentence in a letter, led to the remark, at the close of the first of those articles, that the leaf trap of *Dionæa* had been paralyzed by one side in consequence of a dexterous puncture. What was communicated really related to *Drosera*.

This language implies that the animal matter is in some way or other discerned by the tentacles, and is appropriated. Formerly there was only a presumption of this, on the general ground that such an organization could hardly be purposeless. Yet, while such expressions were natural if not unavoidable, they generally were used by those familiar with the facts in a half-serious, half-metaphorical sense. Thanks to Mr. Darwin's investigations, they may now be used in simplicity and seriousness.

That the glands secrete the glairy liquid of the drop is evident, not only from its nature, but from its persistence through a whole day's exposure to a summer sun, as also from its renewal after it has been removed, dried up, or absorbed. That they absorb as well as secrete, and that the whole tentacle may be profoundly affected thereby, are proved by the different effects, in kind and degree, which follow the application of different substances. Drops of rain-water, like single momentary touches of a solid body, produce no effect, as indeed they could be of no advantage; but a little carbonate of ammonia in the water, or an infusion of meat, not only causes inflection, but promptly manifests its action upon the contents of the cells of which the tentacle is constructed. These cells are sufficiently transparent to be viewed under the microscope without dissection or other interference; and the change which takes place in the fluid contents of these cells when the gland above has been acted upon is often visible through a weak lens, or sometimes even by the naked eye, although higher powers are required to discern what actually takes place. This change, which Mr. Darwin discovered, and turns to much account in his researches, he terms "aggregation of the protoplasm." When untouched and quiescent, the contents appear as a homogeneous purple fluid. When the gland is acted upon, minute purple particles appear, suspended in the now colorless or almost colorless fluid; and this change appears first in the cells next the gland, and then in those next beneath, travelling down the whole length of the tentacle. When the action is slight, this appearance does not last long; the particles of "aggregated protoplasm" redissolve, the process of redissolution travelling upwards from the base of the tentacle to the gland in a reverse direction to that of the aggregation. Whenever the action is more prolonged or intense, as when a bit of meat or crushed fly, or a fitting solution, is left upon the gland, the aggregation proceeds farther, so that the whole protoplasm of each cell condenses into one or two masses, or into a single mass which will often separate into two, which afterwards reunite; indeed they incessantly change their forms and positions, being never at rest, although their movements are rather slow. In appearance and movements they are very like amœbæ and the white corpuscles of the blood. Their motion, along with the streaming movement of rotation in the layer of white granular protoplasm that flows along the walls of the cell, under the high powers of the microscope "presents a wonderful scene of vital activity." This continues while the tentacle is inflected or the gland fed by animal matter, but vanishes by dissolution when the work is over and the tentacle straightens. That absorption takes place, and matter is conveyed from cell to cell, is well made out, especially by the experiments with carbonate of ammonia. Nevertheless, this "aggregation" is not dependent upon absorption, for it equally occurs from mechanical irritation of the gland, and always accompanies inflection, however caused, though it may take place without it. This is also apparent from the astonishingly minute quantity of certain substances which suffices to produce sensible inflection and aggregation—such, for instance, as the one-twenty-millionth or even the thirty-millionth of a grain of phosphate or nitrate of ammonia!

By varied experiments it was found that the nitrate of ammonia was more powerful than the carbonate, and the phosphate more powerful than the nitrate, this result being intelligible from the difference in the amount of nitrogen in the first two salts, and from the presence of phosphorus in the third. There is nothing surprising in the absorption of such extremely dilute solutions by a gland. As our author remarks: "All physiologists admit that the roots of plants absorb the salts of ammonia brought to them by the rain; and fourteen gallons of rain-water [*i.e.*, early rain-water] contain a grain of ammonia; therefore, only a little more than twice as much as in the weakest solution employed by me. The fact which appears truly wonderful is that the one twenty-millionth of a grain of the phosphate of ammonia, including less than one thirty-millionth of efficient matter [if the water of crystallization is deducted], when absorbed by a gland, should induce some change in it which leads to a motor impulse being transmitted down the whole length of the tentacle, causing its basal part to bend, often through an angle of 180°." But odoriferous particles which act upon the nerves of animals must be infinitely smaller, and by these a dog a quarter of a mile to the leeward of a deer perceives his presence by some change in the olfactory nerves transmitted through them to the brain.

When Mr. Darwin obtained these results fourteen years ago, he could claim for *Drosera* a power and delicacy in the detection of minute quantities of a substance far beyond the resources of the most skilful chemist; but in a foot-note he admits that "now the spectroscope has altogether beaten *Drosera*; for, according to Bunsen and Kirchhoff, probably less than the 1-200,000,000th of a grain of sodium can be thus detected."

Finally, that this highly sensitive and active living organism absorbs, will not be doubted when it is proved to digest, that is, to dissolve otherwise insoluble animal matter by the aid of special secretions. That it does this is now past doubting. In the first place, when the glands are excited they pour forth an increased amount of the ropy secretion. This occurs directly when a bit of meat is laid upon the central glands; and the influence which they transmit to the long-stalked marginal glands causes them, while incurving their tentacles, to secrete more copiously long before they have themselves touched anything. The primary fluid, secreted without excitation, does not of itself digest. But the secretion under excitement changes in nature and becomes acid. So, according to Schiff, mechanical irritation excites the glands of the stomach to secrete an acid. In both this acid appears to be necessary to, but of itself insufficient for, digestion. The requisite solvent, a kind of ferment called *pepsin*, which acts only in the presence of the acid, is poured forth by the glands of the stomach only after they have absorbed certain soluble nutritive substances of the food; then this pepsin promptly dissolves muscle, fibrin, coagulated albumen, cartilage, and the like. Similarly it appears that *Drosera*-glands, after irritation by particles of glass, did not act upon little cubes of albumen. But when moistened with saliva, or replaced by bits of roast meat or gelatine, or even cartilage, which supply some soluble *peptone*-matter to initiate the process, these substances are promptly acted upon, and dissolved or digested; whence it is inferred that the analogy with the stomach holds good throughout, and that a ferment similar to pepsin is poured out under the stimulus of some soluble animal matter. But the direct evidence of this is furnished only by the related carnivorous plant, *Dionæa*, from which the secretions, poured out when digestion is about to begin, may be collected in quantity sufficient for chemical examination. In short, the experiments show "that there is a remarkable accordance in the power of digestion between the gastric juice of animals, with its pepsin and hydrochloric acid, and the secretion of *Drosera*, with its ferment and acid belonging to the acetic series. We can, therefore, hardly doubt that the ferment in both cases is closely similar, if not identically the same. That a plant and an animal should pour forth the same, or nearly the same, complex secretion, adapted for the same purpose of digestion, is a new and wonderful fact in physiology."

There are one or two other species of Sundew—one of them almost as common in Europe and North America as the ordinary round-leaved species—which act in the same way, except that, having their leaves longer in proportion to their breadth, their sides never curl inward, but they are much disposed to aid the action of their tentacles by incurving the tip of the leaf, as if to grasp the morsel. There are many others, with variously less efficient and less advantageously arranged insectivorous apparatus, which, in the language of the new science, may be either on the way to acquire something better, or of losing what they may have had, while now adapting themselves to a proper vegetable life. There is one member of the family (*Drosophyllum Lusitanicum*), an almost shrubby plant, which grows on dry and sunny hills in Portugal and Morocco—which the villagers call "the fly-catcher," and hang up in their cottages for the purpose—the glandular tentacles of which have wholly lost their powers of movement, if they ever had any, but which still secrete, digest, and absorb, being roused to great activity by the contact of any animal matter. A friend of ours once remarked that it was fearful to contemplate the amount of soul that could be called forth in a dog by the sight of a piece of meat. Equally wonderful is the avidity for animal food manifested by these vegetable tentacles, that can "only stand and wait" for it.

Only a brief chapter is devoted to *Dionæa* of North Carolina, the Venus' Fly-Trap, albeit, "from the rapidity and force of its movements, one of the most wonderful in the world." It is of the same family as the Sundew; but the action is transferred from tentacles on the leaf to the body of the leaf itself, which is transformed into a spring-trap, closing with a sudden movement over the alighted insect. No secretion is provided beforehand either for allurement or detention; but after the captive is secured, microscopic glands within the surface of the leaf pour out an abundant gastric juice to digest it. Mrs. Glass's classical directions in the cook-book, "first catch your hare," are implicitly followed.

Avoiding here all repetition or recapitulation of our former narrative, suffice it now to mention two interesting recent additions to our knowledge, for which we are indebted to Mr. Darwin. One is a research, the other an in-

spiration. It is mainly his investigations which have shown that the glairy liquid, which is poured upon and macerates the captured insect, accomplishes a true digestion; that, like the gastric juice of animals, it contains both a free acid and pepsin or its analogue, these two together dissolving albumen, meat, and the like. The other point relates to the significance of a peculiarity in the process of capture. When the trap suddenly encloses an insect which has betrayed its presence by touching one of the internal sensitive bristles, the closure is at first incomplete. For the sides approach in an arching way, surrounding a considerable cavity, and the marginal spine-like bristles merely intercross their tips, leaving intervening spaces through which one may look into the cavity beneath. A good idea may be had of it by bringing the two palms near together to represent the sides of the trap, and loosely interlocking the fingers to represent the marginal bristles or bars. After remaining some time in this position the closure is made complete by the margins coming into full contact, and the sides finally flattening down so as to press firmly upon the insect within; the secretion excited by contact is now poured out, and digestion begins. Why these two stages? Why should time be lost by this preliminary and incomplete closing? The query probably was never distinctly raised before, no one noticing anything here that needed explanation. Darwinian teleology, however, raises questions like this, and Mr. Darwin not only propounded the riddle but solved it. The object of the partial closing is to permit small insects to escape through the meshes, detaining only those plump enough to be worth the trouble of digesting. For naturally only one insect is caught at a time, and digestion is a slow business with Dionæas, as with anacondas, requiring ordinarily a fortnight. It is not worth while to undertake it with a gnat when larger game may be had. To test this happy conjecture, Mr. Canby was asked, on visiting the Dionæas in their native habitat, to collect early in the season a good series of leaves in the act of digesting naturally-caught insects. Upon opening them it was found that ten out of fourteen were engaged upon relatively large prey, and of the remaining four three had insects as large as ants, and one a rather small fly.

"There be land-rats and water-rats" in this carnivorous Sundew family. *Aldrovanda*, of the warmer parts of Europe and of India, is an aquatic plant, with bladdery leaves, which were supposed to be useful in rendering the herbage buoyant in water. But it has recently been found that the bladder is composed of two lobes, like the trap of its relative *Dionæa*, or the valves of a mussel-shell; that these open when the plant is in an active state, are provided with some sensitive bristles within, and when these are touched close with a quick movement. These water-traps are manifestly adapted for catching living creatures; and the few incomplete investigations that have already been made render it highly probable that they appropriate their prey for nourishment, whether by digestion or by mere absorption of decomposing animal matter, is uncertain. It is certainly most remarkable that this family of plants, wherever met with, and under the most diverse conditions and modes of life, should always in some way or other be predaceous and carnivorous.

If it be not only surprising but somewhat confounding to our classifications that a whole group of plants should subsist partly by digesting animal matter and partly in the normal way of decomposing carbonic acid and producing the basis of animal matter, we have, as Mr. Darwin remarks, a counterpart anomaly in the animal kingdom. While some plants have stomachs, some animals have roots. "The rhizocephalous crustaceans do not feed like other animals by their mouths, for they are destitute of an alimentary canal, but they live by absorbing through root-like processes the juices of the animals on which they are parasitic."

SOME RECENT VOLUMES OF POETRY.*

A NEW volume of poems by Mr. Longfellow is a pleasure alike for the oldest and the youngest reader of poetry. No other living poet has so wide and so affectionate an audience as he, and that this should be the case is an indication of the good taste and good feeling of the average reader. Among the most marked civilizing influences of the literature of our time is that which has been exerted by Mr. Longfellow's poetry from the date of the original publication of the 'Voices of the Night,' thirty-seven years ago, to the present day. His successive volumes have been chapters of spiritual autobiography, with all the intimacy but nothing of the conceit of personal narrative. Sweet and sincere feeling has been expressed in verse as sweet as the sentiment by which it was inspired. The harmony of emotion and thought with the form of their utterance has seldom been more completely realized than in Mr. Longfellow's work. He has been steadily true to his own genius; always modest in performance, never straining his forces, never striving for factitious effect, but faithfully cultivating his art, and setting an eminent example of poetic virtues rare in these days of impatient and inconsiderate rhymsters. It is the character of the man that has shaped and moulded his verse into conformity with its own pure morality, generous sympathies, and delicate feeling. A new volume of such a poet is not to be criticised as if it were by an unknown writer. It comes to us invested with associations and memories. Its tones awaken familiar echoes. We read it with ears already attuned to its harmonies.

The 'Masque of Pandora' is a dramatic and lyric interlude, in which the well-known Greek myth is developed, not with classic severity of treatment, but with a romantic freedom that brings it into closer relation with modern moods of sentiment and reflection. The spirit of the poem partakes more of the grace and pathos of the legend than of its dread horror and of the boding mystery, whether of good or of evil, that attends the outcome of the deed of Pandora. We spoke last year of the domestic charm of the 'Hanging of the Crane,' and we can but repeat our sense of the success with which Mr. Longfellow has represented the inner circle of household joys and sorrows. His "Morituri Salutamus," though an occasional poem, rises, by virtue of its excellence, into the ranks of poems that outlive their occasion. All our readers are familiar with its manly and affecting simplicity and earnestness of address. We accept it as proof not of the age but of the perennial, healthy youth of the poet. But of all the contents of the volume, the last part, the Book of Sonnets, is that which shows Mr. Longfellow at his best. He is master of the form of the sonnet, and the form, by its very stress and limitations, seems to give completeness, compactness, and vigor to its contents. In these admirable poems, the poet, the artist, and the man find their fullest expression.

To turn from such perfected work as this to the sonnets of 'The New Day: a Poem in Songs and Sonnets,' is like the change from the lyre of Orpheus to the "pipes made of green corn" of Chaucer's "little herd grooms," on which, indeed, they play sweetly and deftly enough, but not yet with full power, and not yet as masters of nobler instruments. There is sincerity of emotion, delicacy of expression, seriousness of intention, and artistic capacity enough in Mr. Gilder's verses to give ground for hope that with larger experience and faithful culture he will write such poetry as will add preciousness even to these first works of his muse. He may fill these, indeed, with fuller virtue than they now hold if his future work show that this first volume was but the firm and modest foundation of genuine achievement. The qualities in this volume are indicative of true poetic sensibility, and of potential success. The defects are mainly those of youthful impressibility. The title of the volume, 'The New Day,' would hardly have been given to it if Mr. Gilder had not been moved by 'The New Life,' and his verse often suggests a reminiscence of Dante's love-poems, or those of some more recent poet. But youth has its charm, even when it is trying its wings. Its imitative flutterings are preludes to original flights. And the intensity and purity of Mr. Gilder's love are of the best possible promise as regards his future poetic accomplishment. We shall look for his next volume with sincere, sympathetic interest, and with great confidence that it will, if he can but hold fast his ideal, receive the welcome he would desire for it.

Mr. Lathrop's little volume deserves to be mentioned in similar terms. It is the work of a sincere and pure youth. His feeling and his expression are alike refined, and he has the sentiment of the poet and of the artist. His volume does credit to the society in which such sentiment is possible, but he will not object to the criticism that his range of experience is as yet too limited to give him a right to expect a wide recognition from the indifferent public as the poet of their needs, desires, and aspirations. The sentiments and the sensibilities of an individual must be fused into the great current of universal emotions and passions before the poet can claim an audience beyond the number of his personal friends, or of the few unknown to him with like natures to his own. Mr. Lathrop has the making of a poet in him, and it is long since we had to notice two volumes that gave more hope for the future of their authors than 'Rose and Roof-Tree' and 'The New Day.'

A generation has passed, full of marvellous turmoils and changes, since Mr. Cranch published his former thin volume of poems. Yet there are

* 'The Masque of Pandora, and other Poems. By Henry Wadsworth Longfellow.' Boston: James R. Osgood & Co. 1875. 16mo, pp. 146.
'The New Day: A Poem in Songs and Sonnets. By Richard Watson Gilder.' New York: Scribner, Armstrong & Co. 1875. Sq. 16mo, pp. 112.
'Rose and Roof-Tree: Poems. By George Parsons Lathrop.' Boston: James R. Osgood & Co. 1875. 16mo pp. 126.
'The Bird and the Bell, with other Poems. By Christopher Pearse Cranch.' Boston: J. R. Osgood & Co. 1875.
'American Boyhood. By Horace P. Biddle.' Philadelphia: J. B. Lippincott & Co. 1875. 12mo, 228.
'The Ship in the Desert. By Joaquin Miller.' Boston: Roberts Brothers. 1875. 16mo, pp. 205.

tion in the use of the rod and gun, and all that relates to the exigencies of field and forest life. Dr. Rothrock, who proposes to undertake this, was a pupil of Agassiz, Wyman, and Gray at Harvard, and has won distinction already as botanist, surgeon, teacher, and frontier explorer.

—We had hardly disposed of the case of the *Evening Post* when we caught the *Times* once more in its old practice of "journalizing." The *Nation*, November 4, 1875, called the effort of the Mayor and Public Works Department to pay the market rate of wages—

"The first show of an attempt to carry on the government of the city on business principles."

The above, as journalized by the New York *Times*, January 7, 1876 :

"The first honest attempt which has been made to conduct the government of this city on business principles."

This is a worse case than it seems on the surface.

DARWIN'S INSECTIVOROUS AND CLIMBING PLANTS.*

II.

TO a naturalist of our day, imbued with those ideas of the solidarity of organic nature which such facts as those we have been considering suggest, the greatest anomaly of all would be that they are really anomalous or unique. Reasonably supposing, therefore, that the Sundew did not stand alone, Mr. Darwin turned his attention to other groups of plants ; and, first, to the Bladderworts, which have no near kinship with the Sundews, but, like the aquatic representative of that family, are provided with bladdery sacs, under water. In the common species of *Utricularia* or Bladderwort, these little sacs, hanging from submerged leaves or branches, have their orifice closed by a lid which opens inwardly—a veritable trap-door. It had been noticed in England and France that they contained minute crustacean animals. Early in the summer of 1874, Mr. Darwin ascertained the mechanism for their capture and the great success with which it is used. But before his account was written out, Prof. Cohn published an excellent paper on the subject in Germany, and Mrs. Treat, of Vineland, New Jersey, a still earlier one in this country—in the New York *Tribune* in the autumn of 1874. Of the latter, Mr. Darwin remarks that she "has been more successful than any other observer in witnessing the actual entrance of these minute creatures." They never come out, but soon perish in their prison, which receives a continued succession of victims, but little, if any, fresh air to its water. The action of the trap is purely mechanical, without evident irritability in the opening or shutting. There is no evidence nor much likelihood of any proper digestion ; indeed, Mr. Darwin found evidence to the contrary. But the more or less decomposed and dissolved animal matter is doubtless absorbed into the plant ; for the whole interior of the sac is lined with peculiar, elongated and four-armed very thin-walled processes, which contain active protoplasm, and which were proved by experiment to "have the power of absorbing matter from weak solutions of certain salts of ammonia and urea, and from a putrid infusion of raw meat."

Although the Bladderworts "prey on garbage," their terrestrial relatives "live cleanly," as nobler plants should do, and have a good and true digestion. *Pinguicula*, or Butterwort, is the representative of this family upon land. It gets both its Latin and its English name from the fatty or greasy appearance of the upper face of its broad leaves ; and this appearance is due to a dense coat or pile of short-stalked glands, which secrete a colorless and extremely viscid liquid. By this small flies, or whatever may alight or fall upon the leaf, are held fast. These waifs might be useless or even injurious to the plant. Probably Mr. Darwin was the first to ask whether they might be of advantage. He certainly was the first to show that they probably are so. The evidence from experiment, shortly summed up, is, that insects alive or dead, and also other nitrogenous bodies, excite these glands to increased secretion ; the secretion then becomes acid, and acquires the power of dissolving solid animal substances—that is, the power of digestion in the manner of *Drosera* and *Dionæa*. And the stalks of their glands under the microscope give the same ocular evidence of absorption. The leaves of the Butterwort are apt to have their margins folded inward, like a rim or hem. Taking young and vigorous leaves to which hardly anything had yet adhered, and of which the margins were still flat, Mr. Darwin set within one margin a row of small flies. Fifteen hours afterwards this edge was neatly turned inward, partly covering the row of flies, and the surrounding glands were secreting copiously. The other edge remained flat and unaltered. Then he stuck a fly to the middle of a leaf just below its tip, and soon both margins infolded, so as to clasp the object. Many other and varied experiments yielded similar results. Even pollen, which would not rarely be lodged upon these leaves, as it falls from surrounding wind-fertilized plants, also small seeds, excited the same action, and showed signs of being acted upon. "We may therefore conclude," with Mr. Darwin, "that *Pinguicula vulgaris*, with its small roots, is not only supported to a large extent by the extraordinary number of insects which it habitually captures, but likewise draws some nourishment from the pollen, leaves, and seeds of other plants which often adhere to its leaves. It is therefore partly a vegetable as well as an animal feeder."

What is now to be thought of the ordinary glandular hairs which render the surface of many and the most various plants extremely viscid ? Their number is legion. The Chinese Primrose of common garden and house culture is no extraordinary instance ; but Mr. Francis Darwin, counting those on a small space measured by the micrometer, estimated them at 65,371 to the square inch of foliage, taking in both surfaces of the leaf, or two or three millions on a moderate-sized specimen of this small herb. Glands of this sort were loosely regarded as organs for excretion, without much consideration of the question whether, in vegetable life, there could be any need to excrete, or any advantage gained by throwing off such products ; and, while the popular name of Catch-fly, given to several common species of *Silene*, indicates long familiarity with the fact, probably no one ever imagined that the swarms of small insects which perish upon these sticky surfaces were ever turned to account by the plant. In many such cases, no doubt they perish as uselessly as when attracted into the flame of a candle. In the Tobacco plant, for instance, Mr. Darwin could find no evidence that the glandular hairs absorb animal matter. But Darwinian philosophy expects all gradations between casualty and complete adaptation. It is probable that any thin-walled vegetable structure which secretes may also be capable of absorbing under favorable conditions. The myriad exquisitely-constructed glands of the Chinese Primrose are not likely to be functionless. Mr. Darwin ascertained by direct experiment that they promptly absorb carbonate of ammonia, both in watery solution and in vapor. So, since rain-water usually contains a small percentage of ammonia, a use for these glands becomes apparent—one completely congruous with that of absorbing any animal matter, or products of its decomposition, which may come in their way through the occasional entanglement of insects in their viscid secretion. In several Saxifrages—distant relatives of *Drosera*—the viscid glands equally manifested the power of absorption.

To trace a gradation between a simply absorbing hair with a glutinous tip, through which the plant may perchance derive slight contingent advantage, and the tentacles of a Sundew, with their exquisite and associated adaptations, does not much lessen the wonder nor explain the phenomena. After all, as Mr. Darwin modestly concludes, "we see how little has been made out in comparison with what remains unexplained and unknown." But all this must be allowed to be an important contribution to the doctrine of the gradual acquirement of uses and functions, and hardly to find conceivable explanation upon any other hypothesis.

There remains one more mode in which plants of the higher grade are known to prey upon animals ; namely, that of pitchers, urns, or tubes, in which insects and the like are drowned or confined, and either macerated or digested. To this Mr. Darwin barely alludes on the last page of the present volume. The main facts known respecting the American pitcher-plants have, as was natural, been ascertained in this country, and we gave an abstract two years ago of our then incipient knowledge. Much has been learned since, although all the observations have been of a desultory character. If space permitted, an instructive narrative might be drawn up, as well of the economy of the *Sarracenias* as of how we came to know what we do of it. But the very little we have room for will be strictly supplementary to our former article.

The pitchers of our familiar northern *Sarracenia*, which is likewise southern, are open-mouthed ; and, although they certainly secrete some liquid when young, must derive most of the water they ordinarily contain from rain. How insects are attracted is unknown, but the water abounds with their drowned bodies and decomposing remains.

In the more southern *S. flava* the long and trumpet-shaped pitchers evidently depend upon the liquid which they themselves secrete, although at maturity, when the hood becomes erect, rain may somewhat add to it. This species, as we know, allures insects by a peculiar sweet exudation within the orifice ; they fall in and perish, though seldom by drowning, yet few are able to escape ; and their decomposing remains accumulate in the narrow bottom of the vessel. Two other long-tubed species of the Southern

* 'Insectivorous Plants. By Charles Darwin, M.A., F.R.S.' With Illustrations. London : John Murray. 1875. Pp. 462. New York : D. Appleton & Co.
'The Movements and Habits of Climbing Plants. By Charles Darwin, M.A., F.R.S., etc.' Second Edition revised, with Illustrations. London : John Murray. 1875. Pp. 278. New York : D. Appleton & Co.

States are similar in these respects. There is another, *S. psittacina*, the parrot-headed species, remarkable for the cowl-shaped hood so completely inflexed over the mouth of the small pitcher that no rain can possibly enter. Little is known of its efficiency as a fly-catcher; but its conformation has a morphological interest, leading up as it does to the Californian type of pitcher presently to be mentioned.

But the remaining species, *S. variolaris*, is the most wonderful of our pitcher-plants in its adaptations for the capture of insects. The inflated and mottled lid or hood overarches the ample orifice of the tubular pitcher sufficiently to ward off the rain, but not to obstruct the free access of flying insects. Flies, ants, and most insects glide and fall from the treacherous smooth throat into the deep well below, and never escape. They are allured by a sweet secretion just within the orifice—which was discovered and described long ago, and the knowledge of it well-nigh forgotten until recently. And, finally, Dr. Mellichamp, of South Carolina, two years ago made the capital discovery that, during the height of the season, this lure extends from the orifice down nearly to the ground, a length of a foot or two, in the form of a honeyed line or narrow trail on the edge of the wing-like border which is conspicuous in all these species, although only in this one, so far as known, turned to such account. Here, one would say, is a special adaptation to ants and such terrestrial and creeping insects. Well, long before this sweet trail was known, it was remarked by the late Prof. Wyman and others that the pitchers of this species, in the savannahs of Georgia and Florida, contain far more ants than they do of all other insects put together.

Finally, all this is essentially repeated in the peculiar Californian pitcher-plant (*Darlingtonia*), a genus of the same natural family, which captures insects in great variety, enticing them by a sweetish secretion over the whole inside of the inflated hood and that of a curious forked appendage, resembling a fish-tail, which overhangs the orifice. This orifice is so concealed that it can be seen and approached only from below, as if—the casual observer might infer—to escape visitation. But dead insects of all kinds, and their decomposing remains, crowd the cavity and saturate the liquid therein contained, enticed, it is said, by a peculiar odor as well as by the sweet lure which is at some stages so abundant as to drip from the tips of the overhanging appendage. The principal observations upon this pitcher-plant in its native habitat have been made by Mrs. Austin, and only some of the earlier ones have thus far been published by Mr. Canby. But we are assured that in this, as in the *Sarracenia variolaris*, the sweet exudation extends at the proper season from the orifice down the wing nearly to the ground, and that ants follow this honeyed pathway to their destruction. Also, that the watery liquid in the pitcher, which must be wholly a secretion, is much increased in quantity after the capture of insects.

It cannot now well be doubted that the animal matter is utilized by the plant in all these cases, although most probably only after maceration or decomposition. In some of them even digestion, or at least the absorption of undecomposed soluble animal juices, may be suspected; but there is no proof of it. But, if pitchers of the Sarracenia family are only macerating vessels, those of *Nepenthes*—the pitchers of the Indian Archipelago, familiar in conservatories—seem to be stomachs. The investigations of the President of the Royal Society, Dr. Hooker, although incomplete, well-nigh demonstrate that these not only allure insects by a sweet secretion at the rim and upon the lid of the cup, but also that their capture, or the presence within of other partly soluble animal matter, produces an increase and an acidulation of the contained watery liquid, which thereupon becomes capable of acting in the manner of that of *Drosera* and *Dionæa*, dissolving flesh, albumen, and the like.

After all, there never was just ground for denying to vegetables the use of animal food. The Fungi are by far the most numerous family of plants, and they all live upon organic matter, some upon dead and decomposing, some upon living, some upon both; and the number of those that feed upon living animals is large. Whether these carnivorous propensities of higher plants which so excite our wonder be regarded as survivals of ancestral habits, or as comparatively late acquirements, or even as special endowments, in any case what we have learned of them goes to strengthen the conclusion that the whole organic world is akin.

The volume upon 'The Movements and Habits of Climbing Plants' is a revised and enlarged edition of a memoir communicated to the Linnean Society in 1865, and published in the ninth volume of its Journal. There was an extra impression, but, beyond the circle of naturalists, it can hardly have been much known at first-hand. Even now, when it is made a part of the general Darwinian literature, it is unlikely to be as widely read as the companion volume which we have been reviewing; although it is really a more readable book, and well worthy of far more extended notice at our hands than it can now receive. The reason is obvious. It seems as natural that plants should climb as it does unnatural that any should take animal food. Most people, knowing that some plants "twine with the sun," and others "against the sun," have an idea that the sun in some way causes the twining: indeed, the notion is still fixed in the popular mind that the same species twines in opposite directions north and south of the equator.

Readers of this fascinating treatise will learn, first of all, that the sun has no influence over such movements directly, and that its indirect influence is commonly adverse or disturbing, except the heat, which quickens vegetable as it does animal life. Also, that climbing is accomplished by powers and actions as unlike those generally predicated of the vegetable kingdom as any which have been brought to view in the preceding volume. Climbing plants "feel" as well as "grow and live"; and they also manifest an automatism which is perhaps more wonderful than a response by visible movement to an external irritation. Nor do plants grow up their supports, as is unthinkingly supposed; for, although only growing or newly grown parts act in climbing, the climbing and the growth are entirely distinct. To this there is one exception—an instructive one, as showing how one action passes into another, and how the same result may be brought about in different ways—that of stems which climb by rootlets, such as of Ivy and Trumpet Creeper. Here the stem ascends by growth alone, taking upward direction, and is fixed by rootlets as it grows. There is no better way of climbing walls, precipices, and large tree-trunks.

But small stems and similar supports are best ascended by twining; and this calls out powers of another and higher order. The twining stem does not grow around its support, but winds around it, and it does this by a movement the nature of which is best observed in stems which have not yet reached their support, or have overtopped it and stretched out beyond it. Then it may be seen that the extending summit, reaching farther and farther as it grows, is making free circular sweeps, by night as well as by day, and irrespective of external circumstances, except that warmth accelerates the movement, and that the general tendency of young stems to bend towards the light may, in case of lateral illumination, accelerate one-half the circuit while it equally retards the other. The arrest of the revolution where the supporting body is struck, while the portion beyond continues its movement, brings about the twining. As to the proximate cause of this sweeping motion, a few simple experiments prove that it results from the bowing or bending of the free summit of the stem into a more or less horizontal position, this bending being successively to every point of the compass, through an action which circulates around the stem in the direction of the sweep and of the consequent twining, *i.e.*, "with the sun" or with the movement of the hands of a watch in the hop, or in the opposite direction in pole-beans and most twiners.

Twining plants, therefore, ascend trees or other stems by an action and a movement of their own, from which they derive advantage. To plants liable to be overshadowed by more robust companions, climbing is an economical method of obtaining a freer exposure to light and air with the smallest possible expenditure of material. But twiners have one disadvantage: to rise ten feet they must produce fifteen feet of stem or thereabouts, according to the diameter of the support and the openness or closeness of the coil. A rootlet-climber saves much in this respect, but has a restricted range of action and other disadvantages.

There are two other modes, which combine the utmost economy of material with freer range of action. There are, in the first place, leaf-climbers of various sorts, agreeing only in this, that the duty of laying hold is transferred to the leaves, so that the stem may rise in a direct line. Sometimes the blade or leaflets, or some of them, but more commonly their slender stalks, undertake the work, and the plant rises as a boy ascends a tree, grasping first with one hand or arm, then with the other. Indeed, the comparison, like the leaf-stalk, holds better than would be supposed; for the grasping of the latter is not the result of a blind groping in all directions by a continuous movement, but of a definite sensitiveness which acts only upon the occasion. Most leaves make no regular sweeps; but when the stalks of a leaf-climbing species come into prolonged contact with any fitting extraneous body, they slowly incurve and make a turn around it, and then commonly thicken and harden until they attain a strength which may equal that of the stem itself. Here we have the faculty of movement to a definite end, upon external irritation, of the same nature with that displayed by *Dionæa* and *Drosera*, although slower for the most part than even in the latter. But the movement of the hour-hand of the clock is not different in nature or cause from that of the second-hand.

Finally—distribution of office being on the whole most advantageous and economical, and this in the vegetable kingdom being led up to by de-

gress—we reach, through numerous gradations, the highest style of climbing plants in the tendril-climber. A tendril, morphologically, is either a leaf or branch of stem, or a portion of one, specially organized for climbing. Some tendrils simply turn away from light, as do those of grape-vines, thus taking the direction in which some supporting object is likely to be encountered; most are indifferent to light; and many revolve in the manner of the summit of twining stems. As the stems which bear these highly-endowed tendrils in many cases themselves also revolve more or less, though they seldom twine, their reach is the more extensive; and to this endowment of automatic movement most tendrils add the other faculty, that of incurving and coiling upon prolonged touch, or even brief contact, in the highest degree. Some long tendrils, when in their best condition, revolve so rapidly that the sweeping movement may be plainly seen; indeed, we have seen a quarter circuit in a *Passiflora sicyoides* accomplished in less than a minute, and the half circuit in ten minutes; but the other half (for a reason alluded to in the next paragraph) takes a much longer time. Then as to the coiling upon contact, in the case first noticed in this country in the year 1858, which Mr. Darwin mentions as having led him into this investigation, the tendril of *Sicyos* was seen to coil within half a minute after a stroke with the hand, and to make a full turn or more within the next minute; furnishing ocular evidence that tendrils grasp and coil in virtue of sensitiveness to contact, and, one would suppose, negativing Sachs's recent hypothesis that all these movements are owing "to rapid growth on the side opposite to that which becomes concave"—a view to which Mr. Darwin objects, but not as strongly as he might. The tendril of this sort, on striking some fitting object, quickly curls round and firmly grasps it; then, after some hours, one side shortening or remaining short in proportion to the other, it coils into a spire, dragging the stem up to its support, and enabling the next tendril above to secure a readier hold.

In revolving tendrils perhaps the most wonderful adaptation is that by which they avoid attachment to or winding themselves upon the ascending summit of the stem that bears them. This they would inevitably do if they continued their sweep horizontally. But when in its course it nears the parent stem the tendril moves slowly, as if to gather strength, then stiffens and rises into an erect position parallel with it, and so passes by the dangerous point; after which it comes rapidly down to the horizontal position, in which it moves until it again approaches and again avoids the impending obstacle.

Climbing plants are distributed throughout almost all the natural orders. In some orders climbing is the rule, in most it is the exception, occurring only in certain genera. The tendency of stems to move in circuits—upon which climbing more commonly depends, and out of which it is conceived to have been educed—is manifested incipiently by many a plant which does not climb. Of those that do there are all degrees, from the feeblest to the most efficient, from those which have no special adaptation to those which have exquisitely endowed special organs for climbing. The conclusion reached is that the power "is inherent, though undeveloped, in almost every plant"; "that climbing plants have utilized and perfected a widely-distributed and incipient capacity which, as far as we can see, is of no service to ordinary plants."

Inherent powers and incipient manifestations, useless to their possessors but useful to their successors—this doubtless is according to the order of nature; but it seems to need something more than natural selection to account for it.

RECENT NOVELS.*

'ST. SIMON'S NIECE' is a story of the Colony—in other words, the American colony in Paris. It treats of a young lady who lives with her uncle and aunt—the former a dissolute adventurer of elegant appearance and charming manners, the latter an old lady known as the "Tortoise," and possessed of many singular attributes. The niece of this ill-assorted couple is in love with Talbot Castlemaine (the finest thing yet in names, it strikes us), who is also a dissolute adventurer of a fascinating exterior. The young lady herself is decidedly dissolute as well, and of course most fascinating, as may be illustrated by her constant habit of addressing her aunt—the "Tortoise"—as "T." They live, as we have said, in Paris, in the Avenue Friedland, together with Gregory Alleyne, Helen Devereux, Marian Payne, and Roland Spencer. "They are all, even the "Tortoise," remarkably handsome; they possess lots of money; and they are all having, as the envious home-phrase is, "a delightful time over there." Talbot Castlemaine is indeed an Englishman (he is especial is as beautiful as a god), and he marries Marian Payne, who becomes Lady Castlemaine. Helen Devereux, however, is the most brilliant figure, for of her these things are related: "This round of visits among some of the most charming country-houses in England was a sufficiently new experience to be very agreeable, and I might crowd several chapters with the stereotyped accounts of hunts, dinners, county-balls, and the like. I might add to the list three days spent at the Royal castle which overlooks Windsor town—rather long, heavy days, Miss Devereux was forced to admit, under her breath—and a week in the quiet of Chiselhurst, where her old admiration for the most gracious, winning woman of our century warmed into a higher homage at the sight of the uncomplaining fortitude which ennobled that uncrowned brow." The touch about the young lady being bored with the society of the Queen of England, and yet keeping her ennui to herself lest the Queen should be distressed, strikes us as particularly fine. As she stayed a whole week with the Empress of the French, it is to be hoped that, in spite of this lady's sad situation, she found things more lively. But what does Mr. Benedict mean by his allusion to the "uncrowned brow" of the Empress? It seems ambiguous; for, to remind us that she never had been crowned diminishes the pathos of his image, and yet, as she never had been crowned, the phrase of course cannot be an inadvertence for *dis*crowned. Miss Devereux, at any rate, afterwards went to Italy. "The court had left *bella Firenze*, but it was very pleasant there nevertheless, and quite gay. Miss Devereux went out a great deal, and the Castlemaines accompanied her." Miss Devereux is a young girl from New York, without visible protectors or affiliations (she has, indeed, a mamma, who is barely mentioned), who is represented as going hither and thither about Europe at discretion, and occupying, *in propriâ personâ*, a great social position. We think, nevertheless, that when she "went out" in Florence it might have been conceded that she was in the care of the married couple just mentioned, rather than they in hers. This, however, is a peculiarity of Mr. Benedict's young ladies; we are told that in Paris "there was no trace of sadness or gloom in the pretty salons where Fanny St. Simon held sway." We are afraid that Mr. Benedict knows his Paris less well than he would have us believe. To "hold sway" in a salon means, for a woman, if it means anything, to preside in a salon of one's own. But as the author has put his substantive into the plural (and as we take it that he does not mean that Miss St. Simon literally "held," as the phrase is, several distinct salons), it is to be supposed that he simply alludes to his heroine's general sovereignty at evening entertainments. It was certainly very good-natured on the part of the other brilliant ornaments of the French capital to have left it in her hands. Miss Devereux, however, comes over (she has been living in Devonshire) to dispute Miss St. Simon's sway—comes over in a special train, after having telegraphed in advance: "I want an apartment for a month—longer, if I choose; the one we formerly had in the Champs Elysées if possible. They must send from the Café Anglais to manage the dinners." Miss Devereux might have done better for her dinners than to have them "sent in"; but when a poor young lady has to take care of herself, and of her friends as well, to the degree that had fallen to Miss Devereux's lot, she can hardly be expected to keep these little niceties in mind. We are unable to trace further the fortunes of the various members of the "Colony" as Mr. Benedict relates them, and indeed we feel guilty of a certain want of candor in having expatiated on them thus far. 'St. Simon's Niece' is a book to be briefly dismissed—an extremely unpleasant book. Snobbish, vulgar, cheaply meretricious, unwholesome, it reads like the work of a young woman of tawdry imagination, who has battened upon the productions of Miss Braddon and Edmund Yates. We say of a young woman, in spite of the name on the title-page (which may easily be a pseudonym) and because of the intrinsic evidence of the book. The style is inimitably feminine. "So they talked on until Fanny worked herself into one of her nervous states, and was absurdly gay." We think the reader will agree with us that these simple words were not written by a masculine hand.

'Buffets' is a much pleasanter performance; the tone of the story indeed, it must be confessed, is wholesome even to insipidity—unsophisticated to puerility. We cannot say that Mr. Doe's tale has riveted our attention, but it has left an agreeable impression of elevated purpose, of manly sympathies, and even of a slender natural facetiousness. The author has bravely attempted to write a characteristic American novel, which should be a tale of civilization—be void of big-hearted backwoodsmen and of every form of "dialect." He has laid his scene in the city of New York, and he has desired his story to savor of the soil. Unfortunately, his design has been more commendable than his success, and if this is the most that local influences can do for the aspiring and confiding American artist, he will not be encouraged to appeal to them. The first trouble with Mr. Doe's

* 'St. Simon's Niece. A Novel. By Frank Lee Benedict.' New York: Harper & Bros. 1875.

'Buffets. By Charles H. Dee.' Boston: J. R. Osgood & Co. 1875.