CARNIVOROUS PLANTS.

THERE is a beautiful and suggestive thought of Leibniz', that there are three modes of life on this earth, the sleeping life of plants, the dreaming life of animals, and the waking life of man. Any one who has passed through the heart of a great city at earliest dawn in summer, and who has stood in the heart of a great forest at noon, will feel at once the beauty of the analogy, will have traced in himself the impulse to tread softly and speak low in the deep woodland quiet, with its continuous hum of insect life, as if he alone were awake in the midst of a sleeping and dreaming world.

But it is in this dim sleeping world of plants,

> "Where only harmless lights, not hearts, are broken,
> And weep but the sweet-watered summer showers,
> World of white joys, cool dews, and peace unspoken,"

that we are beginning to realize, not only the wonderful functions that plants perform, but the strange activities that are at work to enable them to perform those functions. Accustomed as we are to look upon the life of plants as lower and less developed than that of animals, we have still to remember that it is by their humble agency that that great miracle is wrought which as yet baffles our scientific gaze, the mysterious passing of the inorganic into the organic, of what we are accustomed to call "dead matter" into living tissue, with "organs of reproduction that take hold upon eternity." Animals have no power of assimilating inorganic matter as food. The higher organism can only feed on the lower. It is by the frail instrumentality of the plant that the stupendous energies of the inorganic world are yoked to the car of life, it is the child's palm of the leaf that moulds them into obedience to the laws of organic being, the humble finger of the grass that is fashioning the living world out of the dust of the ground.

I propose, therefore, to give a brief survey of some recent discoveries in vegetable physiology in connection with carnivorous and putriverous plants, and the strange contrivances by which they are enabled to perform their functions as revealed to us by the laborious researches of modern naturalists.

The existence of this curious order of plants, whose very name seems to convey a paradox and embody a physiological heresy, was first suggested by the American botanists, Messrs. Curtis and Canby, in 1834 and 1868, confirmed by Asa Grey, and made by Sir Joseph Hooker the subject of his inaugural address before the British Association in 1874; while shortly after Mr. Darwin published the results of fifteen years' exhaustive researches on the peculiarities of some of the leading representatives of insectivorous plants.

It is scarcely necessary for me to remind even my unscientific readers that a plant supplies itself with carbon from the air, decomposing the carbonic acid by means of the sunlight acting in some way on the chlorophyll, or green colouring matter of the leaf; whilst it obtains water and nitrogen from the soil by means of its roots. But in the order of plants we are now considering the roots are either altogether wanting, as in *Aldrovanda vesiculosa*, or very poorly developed, serving, apparently, merely as suckers to secure a constant supply of moisture for the secretions. The necessary nitrogen is accordingly obtained by absorbing animal matter, either by a process of digestion analogous to that of animal life, or by simple absorption of putrified and decomposed elements.

Most of us are familiar with the little marsh-plant called Sun-dew (*Drosera rotundifolia*) common in upland bogs and very poor soil, with its small round leaves fringed with crimson hairs, each headed with a tiny drop of cool sparkling dew through all the burning heats of summer, whence its poetical name of sun-dew. Mr. Swinburne sings of it sweetly enough—

> "A little marsh-plant, yellow green,
> And pricked at lip with tender red;
> Tread close, and either way you tread,
> Some faint black water sets between,
> Lest you should harm the tender head.
>
> "You call it Sun-dew; how it grows,
> If with its colour it hath breath,
> If life taste sweet to it, if death
> Pain its soft petal, no man knows;
> Man has no sight nor sense that saith."

Alas for the poet! if only he had been naturalist enough to know the voracious and predatory habits of the tender thing of which he sings, the "soft petal" being in reality a cruel and elaborately baited trap. The minute drops of harmless dew which adorn every hair, or tentacle, as Mr. Darwin calls the crimson filaments, from the use to which they are applied, is in reality a drop of very viscid secretion surrounding an extremely sensitive gland. Attracted either by the glitter, or possibly by some honeyed odour, or whatever mysterious instinct it is that draws the child to the unwholesome sweet, insects alight on the leaf. If the delicate feet of the smallest gnat do but touch one of the drops of dew at the end of a single filament, its doom is sealed. Caught by the tenacious secretion, with the sensations one would imagine in this strange world of insect peril of a child stuck up bodily to a gigantic bull's-eye to whose attractions it has incautiously yielded, in vain it endeavours to escape. Slowly the filament begins to bend at its base, transmitting at the same time a motor impulse to the filaments next it, that in their turn begin to converge with pitiless precision on the luckless victim, which is carried to the next inner row of tentacles, and so on to the next, with a curious sort of rolling movement, till it reaches the centre of the disc, the glands at the same time pouring out an acid secretion. By degrees, the central glands acting centrifugally on the rest, all the tentacles become closely inflected on the prey, which is bathed on all sides in the secreted acid, while the disc of the leaf often becomes strongly incurved, forming a sort of impromptu stomach, the whole movement taking place in a period varying from four to ten hours. When the insect alights on the centre of the leaf, the short central filaments are not inflected, but the glands transmit, not only motor power to the external filaments, but also some influence which, before they are brought into contact with the prey, causes them to secrete more actively, and the secretion to become acid. According to Dr. Nitschke, insects are generally killed in about a quarter of an hour, suffocated in the secretion.

The number of insects which thus meet their death must be prodigious. On one leaf alone Mr. Darwin found the remains of thirteen flies, and as a single plant has some six or seven leaves, and the plant itself is very abundant, the tale of the slain must be enormous. The commonest victims are small flies (Diptera), but the Rev. H. M. Wilkinson, on one occasion, observed a large dragon-fly with his body firmly held by two leaves.

The length of time for which a leaf remains inflected varies with the nature of the matter embraced. If it is a particle of inorganic matter, cinder, paper, quill, moss, or any object not yielding nitrogenous matter, not only is the inflection of the filaments comparatively languid, but the leaf quickly re-expands after a period of seventeen hours or so, while flies or other objects capable of supplying the plant with the necessary nitrogen remain closely embraced for periods varying from five to ten days. When the leaves begin to re-expand, the glands cease to secrete, and become dry, the remains of the poor digested fly, bleached and dried, being thus exposed to be carried away by the wind so as to disencumber the leaf. After the expansion is complete, the glands again begin to secrete, and as soon as the full-sized drops are formed, the leaf is ready for renewed action, its vitality being, however, generally consumed after a certain number of captures, when its place is taken by the younger leaves.

The extreme sensitiveness of the glands and the curious specialities of that sensitiveness is one of the most remarkable facts about the plant. One or two touches, or even sharp taps, with a solid object, produce no inflection whatever; and as in high winds the plant must be often brushed by blades of grass and other leaves, this insensibility is of great importance to the plant to prevent its being brought into useless action. But the slightest repeated strokes with a camel's hair brush, or the lightest continued pressure, produce inflection. A particle of the thin end of a woman's hair weighing only $\frac{1}{78700}$ of a grain, and largely supported by a dense fluid, so that practically the pressure must be infinitesimal, is sufficient to produce decided inflection. On the other hand, the repeated strokes of a heavy shower of rain, or the continued pressure of drops of water, produce no inflection whatever. That this curious adaptation of the motor impulse of the plant to its circumstances is of service to it, Darwinists and teleologists would be alike agreed. But when Mr. Darwin proceeds to endeavour to explain it by suggesting that it is a sort of habit the plant has formed, he has recourse to a *Deus ex machinâ* far more arbitrary and incomprehensible than the grossest conception of the teleologist. Just as people often speak of time as the source of all decay, meaning thereby the causes that have their action in time, so Mr. Darwin's "habit" can only be the product of certain mechanical laws of pressure and molecular action which make up the habit of the plant. In what way the mechanical impact of liquids differs from that of solid bodies, so that the one produces no molecular action, and even considerably less than $\frac{1}{78700}$ of a grain of continued impact from the other produces movement, on any theory we are utterly ignorant.

Moderate heat increases the excitability of the plant. A temperature of 120° to 125° Fahrenheit excites the tentacles to quick movement; but a momentary immersion in water of 130° temporarily paralyzes them. This heat rigidity, as it is called by Sachs, is induced in the Sensitive plant by exposure for a few minutes to a temperature of 120° Fahr. (49° Cent.).

These remarkable external movements of Drosera are accompanied by as remarkable molecular changes, and still more perplexing in their nature and origin. No sooner is a gland brought into action, either by direct contact, or by some influence transmitted from the central glands, or by the absorption of minute quantities of nitrogenous fluids, then the homogeneous purple fluid which fills the cells of the gland and pedicel becomes aggregated into variously shaped masses of purple matter suspended in an almost colourless fluid. These little masses of protoplasm incessantly change their shape and position, being never at rest; and are now spherical, now oval, now quite irregular, with necklace-like or club-formed projections. After the purple fluid has become aggregated, the layer of white granular protoplasm which flows round the walls of the cells can be much more clearly seen, till the granules coalesce with the central masses. The current flows at an irregular rate up one wall and down the opposite, round and round. Sometimes it ceases, and the movement is in little waves, whose crests toss across the whole width of the cell, and then sink down again. Altogether Mr. Darwin may well remark that one of these cells, with their ever-changing central masses and with the layer of protoplasm flowing round the walls, presents a wonderful scene of vital activity. As the tentacles re-expand, the aggregated masses dissolve again into the ordinary purple fluid.

As the process of aggregation can be induced by the pressure of insoluble matter, it is evidently independent of the absorption of any matter, and must be of a molecular nature. That the central glands when irritated transmit some influence to the exterior glands, causing them to send back a centripetal influence inducing aggregation, which always travels from the gland down the pedicel, is an instance of reflex action altogether new in vegetable physiology. But the exact nature and origin of the process of aggregation and of the motor impulse is wrapped in the greatest obscurity, Mr. Darwin allowing that no satisfactory theory can be formed of either. On the whole he seems to think the latter is allied to the aggregating process, that the molecules of the cell-walls approach each other in the same way as the "plastidules" within the cells, so producing inflexion. But since, when the central glands are irritated, the motor impulse is transmitted centrifugally, while aggregation only takes place centripetally, and therefore later in time, and on the other hand aggregation can take place without any mechanical movement at all, it seems difficult to derive the one from the other.

That Drosera has not only the power of absorbing matter already in solution, but also of rendering it soluble, in other words of digestion, another fact hitherto unsuspected in the physiology of plants, Mr. Darwin has proved by a long series of experiments. The fact itself was suggested to him by observing that the leaves remained clasped much longer over organic than over inorganic bodies, such as bits of glass, wood, cinder, &c. For the benefit of our unscientific readers, who may be ignorant of the processes of animal digestion, it may be as well to state that the digestion of albuminous substances is effected by means of a ferment, pepsin, together with a weak hydrochloric acid, neither pepsin nor an acid alone having any such power. The same holds good in all points of the digestive powers of the Sun-dew. Not only does the secretion of the glands become acid on mechanical irritation, but this acid alone is incapable of effecting digestion, the proper ferment being only found when nitrogenous matter is present, just as with animals, according to Schaff, mechanical irritation excites the glands of the stomach to secrete an acid, but not pepsin. On the other hand, the neutralization of the acid by an alkali immediately arrests the digestive action of the plant. The plants in Mr. Darwin's possession were put on the most curiously varied diet—white of egg, raw and cooked meat, areolar tissue from the visceral cavity of a toad, fragments of a cat's ear, slices of a dog's tooth, boiled cabbage, cheese, pollen, bits of human nails, balls of hair, &c. Out of this fantastic bill of fare, which sounds much as if it had issued from the gastronomic brain of one of Macbeth's witches, and which would certainly have bewildered digestive organs less intelligent than Drosera's, the plant always selected the substances containing nitrogenous matter. The most marked in the phenomena they presented were the minute cubes of white of egg and of raw meat. The former after two days were often completely dissolved, and most of the liquefied matter absorbed; the latter exhibited the same phenomena as when submitted to the action of gastric juice.

Of the substances rejected by the plant, some of them containing nitrogenous matter, viz., epidermic productions, fibro-elastic tissue, mucin, pepsin, urea, chitine, cellulose, chlorophyll, starch, fat, and oil, it is remarkable that, as far as is known, they are all substances not attacked by the gastric juice of animals. It would seem also, that the Sun-dew has an especial point in common with us, that it is occasionally guilty of that sin which St. Augustine regretfully owns to in his Confessions—"Full feeding sometimes creepeth upon Thy servant, O Lord;" for some of the leaves died from the effect of a surfeit on cheese and raw meat.

As it digests seeds, and pollen, and boiled vegetables, it must be looked upon as is in some measure a vegetable feeder as well as carnivorous in its habits.

The extraordinary sensitiveness of its organization is shown by the fact that the absorption by a gland of only the $\frac{1}{19760000}$ of a grain (·0000033 mg.), that is a little less than the one-twenty-millionth of a grain of phosphate of ammonia, is sufficient to cause the tentacle bearing this gland to bend to the centre of the leaf. But we scarcely see why this fact should have seemed at first so incredible to Mr. Darwin, as even this minute quantity must be large when compared, say, with the infinitesimal dimensions of the solid particles, which, striking on the olfactory nerves of a dog, and effecting all the complicated reflex action of sensation, enable it to follow the scent of game, or track its owner for miles.

The moot point which some objectors have raised, whether after all the plant is benefited by the capture of flies, whether the process is not a purely pathological one, has been set at rest by a series of experiments recently conducted by Mr. Francis Darwin.* He placed in his green-house a number of plants in soup-plates divided into two compartments, and carefully covered over with muslin so that no extraneous flies could get at them. The plants in one compartment were left to gain their nourishment through their roots and leaves in the way that other plants do; in the other compartment the plants were regularly fed at frequent intervals with roast meat of about $\frac{1}{15}$ of a grain in weight.

The experiment was virtually begun on the 5th of July, and by the end of August the plants had flowered and nearly all the seed capsules were ripe. They were then gathered, the plants from three of the plates dried, and the two sets compared in respect to their number, weight, and size, the number of capsules produced, and the weight of the contained seeds. The results obtained are conclusive. The number of the fed plants compared to the unfed was in the proportion of 149 to 100, though at first the latter were slightly in excess. But it was in the structures relating to reproduction that the difference between the two sets was the most marked, the number of the seeds being as 100 to 241·5, and their weight as 100 to 379·7, in other words, the fed plants were able to produce nearly two and a-half as many seeds, and nearly four times as great a weight of seeds, as the unfed. In only one respect was the advantage on the side of the latter, the unfed being slightly taller, but only in the proportion of 100 to 99·9. Similar researches have been recently carried out in Germany by MM. Reiss, Kellerman, and Von Raumer,—the only difference being that the plants were fed on insects instead of roast meat, but with the same result of proving the power of some plants to assimilate previously elaborated protoplasm with such advantage to themselves as to produce more and larger seeds, and bigger roots.

To conclude, however anomalous the conception may seem, a plant of Drosera with the edges of its leaves turned inwards so as to form a temporary stomach, with the glands of the closely inflected tentacles pouring forth their acid secretion which dissolves animal matter afterwards to be absorbed, may be said to feed like an animal. But unlike an animal it drinks by means of its roots; and it must drink largely so as to retain sometimes as many as 260 drops of viscid fluid on one leaf, exposed during the whole day to the heat of a glaring sun.

Let us now pass on to a yet more remarkable plant, the *Dionæa muscipula*, or Venus' Fly-trap, belonging to the same family of the Droseraceæ, and only found in the eastern part of North Carolina, growing like the Sun-dew in marshy places. Introduced in 1768 by the English naturalist Ellis to the notice of Linnæus, he rightly denominated it *miraculum naturæ*. The leaves, springing direct from the root with their foliaceous pedicels, spread themselves in a rosette

* Journal of the Linnæan Society: Botany, vol. xvii., No. 98. 1878.

on the ground, and are bilobed, the two lobes standing at an angle of rather less than a right angle, like a butterfly with its wings only partially expanded. Each leaf is bordered with a row of sharp spikes, which when the leaf-lobes are closed interlock like the teeth of a rat-trap. Three minute filaments placed triangularly so as necessarily to intercept the path of any insect alighting on the leaf, project from the upper surface of each lobe. Let an insect's tender wing, or delicate feet just brush one of these filaments, and instantly, as by some secret spring, the valves of the leaf approach one another and the spikes intercross. If it is too small a fly to afford nourishment to the plant it can squeeze itself through the narrowing bars of its prison house, and escape, when the leaf expands again after some eight and thirty hours, for a more desirable prey. But if the captive is fat and nourishing, the old haunting story of the prisoner who finds the walls of his cell gradually closing in upon him comes true, not in gloomy human dungeons, but down among the starry moss, and windy lights, and lovely glancing things, and all the wide peacefulness of upland nature. Slowly the walls of his leafy prison approach, the intercrossing spikes interlock like the teeth of two combs, the lobes themselves become slightly concave, and the prisoner is gradually but irresistibly crushed to death. Occasionally an active beetle with his wits about him, rapidly gnaws his way through the walls of his living grave, and escapes as other prisoners have done. But generally his lifeless corpse can be traced bulging out between the two partitions, so closely pressed together that if separated by force, they reclose with quite a loud snap.

The curious adaptation of the plant to its wants is shown in the specialized character of the sensitiveness of the filaments. With the Sun-dew, the insect being already held fast by the tenacious secretion, leisurely action is possible, and the plant is accordingly sensitive to the least continued pressure, but not to a momentary touch. With the Dionæa, on the contrary, the action has to be instantaneous, and we find the filaments sensitive to the least stroke but indifferent to a slight continued pressure. A morsel of hair, the tenth part of which would have caused inflexion in Drosera, was cautiously lowered on one of the sensitive filaments, and allowed to rest there, but did not produce the least movement. On the other hand, a cautious touch from an inch of very delicate human hair fixed into a handle instantly caused the lobes to approach one another.

But though quicker in its first movements than Drosera, it seems far more sluggish in its after-operations. Thirty-eight hours elapse before the leaf completely opens again, even when it has caught nothing. But even over a small fly a leaf generally remains closed some ten days, so that the full use of the marginal spikes becomes at once apparent, securing the leaf only closing as a rule over prey sufficient for its purpose. Often a leaf does not again expand, but withers, having apparently performed its function. Vigorous leaves in their native soil are said to open and close three times; but Mrs. Treat of New Jersey, one of the most careful of their American observers, states that they often die of a worn-out digestion over their third fly.

The upper surface of the leaf is thickly studded with small purplish, almost sessile glands; and that these have the power of digestion and absorption, has been proved by repeated experiments; but unlike those of Drosera, they cannot be mechanically irritated; repeated touches produce no aggregation; and they do not secrete unless excited by nitrogenous matter. Even when the leaves closed over little bits of cork, wood, stone, moss, paper, the fragments on the expansion of the leaf were found to be perfectly dry. But a fly, or a small piece of damp meat deposited on one of the lobes without touching the filaments, causes the glands in contact with it to secrete freely, and the lobes after some time gradually to close.

The wonderful discovery made by Dr. Burdon Sanderson, that there exists a normal electrical current in the blade and footstalk, and that when the leaf is irritated, the current is disturbed in the same manner as takes place during the contraction of the muscle of an animal, may ultimately lead to further light as to the leaf's mode of movement.

The curious little plant called *Aldrovanda vesiculosa,* after the great Polish botanist Ulysses Aldrovandi, may be looked upon as a miniature aquatic Dionæa. Altogether destitute of roots, it floats about in stagnant water, with its little whorl of bilobed leaves, which, at a sufficiently high temperature, stand open about as much as the valves of a living mussel shell, and when touched suddenly close. The leaves occasionally contain air bubbles, and were supposed to be bladders for floating the plant, whence its second name, till Stein, in 1873, observed the irritability of the leaves, and suggested their true functions,—a suggestion confirmed by the observations of Professor Cohn, who found the remains of several kinds of crustaceans and larvæ within the leaves of naturally growing plants. The geographical distribution of the plant is remarkable both for its wide extension and narrow circumscription, the plant being found in India, and Australia, and Europe, but at the same time circumscribed to a few spots at wide intervals from each other. In France it is found only in two places, at Raphèle, near Arles, and in a pond not far from Bordeaux. It is pre-eminently, therefore, a botanical rarity, and many points are still obscure with regard to it. As far as present observations go, it is probably related in its functions both to the Droseraceæ, that dissolve by an acid secretion a living prey, or any nitrogenous matter, and to plants like the Utriculariæ that simply absorb decaying and putrid matter.

Having taken the Sun-dew, Venus' Fly-trap, and Aldrovanda, as representatives of the curious family of the Droseraceæ, we will not run the risk of wearying the non-botanical reader by further descriptions of the Drosophyllum of Portugal and Morocco, the giant plant of this order, of Roridula, or Byblis, or *Drosera binata*, though each of these present interesting pecularities; but we will pass on to the wholly unallied order of Lentabulariaceæ (Butterworts) which also present the double characteristic of a vegetable trap and carnivorous habits.

Pinguicula vulgaris is found in mountain marshes, its rather thick oblong light green leaves, one and a-half inches long, being set with glandular hairs that secrete an extremely viscid fluid, to which a number of little insects adhere. The edges of the leaves, thick as they are, have the power of closing in on their prey with an exceedingly slow movement, the secretion being greatly increased and rendered acid by nitrogenous matter as in the Sun-dew. The quickness with which the leaves re-expand, often in less than twenty-four hours, is perplexing. But the usefulness of the movement to the plant notwithstanding, is shown by its transforming the leaf into a sort of channel, into the incurvations of which the hard mountain rains securely wash the captured flies, as well as by the gradual movement often pushing a larger fly into the centre of the leaf, and so bringing it into contact with a greater number of secreting glands.

The Utriculariæ again present us with the curious spectacle of elaborately constructed traps, either above ground or subterranean, or plunged beneath the surface of stagnant ponds and peculiarly foul ditches. The aquatic species, destitute of roots, with their fantastically shaped yellow flowers, are provided with minute translucent bladders attached to their pinnatified leaves, at first thought to be air-floats, till closer observation found they were full of water, and were, in fact, engines for capturing the entomostracan crustaceous larvæ and other minute animals that swarm on stagnant water. My space does not allow my describing the highly complex structure of these curious little mechanisms, with their delicate transparent little trap-door opening from without, but hermetically sealed from within, the approach to it protected by large bristles which ward off any creature of dangerous dimensions that might be tempted to force an entrance. It seems that mischievous curiosity, an unreasoning propensity to poke one's nose into holes and corners where it has no business, is a passion that pervades the universe, and runs animalcules into mischief as well as men. To give the little trap-door a furtive poke, and see what is behind it, seems quite irresistible in the end, even when considerable suspicion and wariness has been evinced; and once touched, it springs open, and claps to again behind the unfortunate prisoner, who after vainly swimming round and round the walls of his watery dungeon at length dies of asphyxia and exhausted oxygen. Mrs. Treat, who has carefully observed these plants, regards the bladder as a stomach that digests its prey; but on this point Mr. Darwin is exceedingly sceptical, since small cubes of white of egg remained unaltered for three days and a half in the bladder, exhibiting none of the familiar phenomena of digestion. But he allows the possibility of the bladders secreting some ferment hastening the process of decay, after the analogous fact stated by Brown, in his Natural History of Jamaica, that meat soaked in water mingled with the milky juice of the Papaw, soon becomes tender, and passes quickly into a state of putridity. At any rate, there seems to be no question that the curious little quadrifid, or four-armed processes which star the interior surface of the bladder absorb putrid matter. Without dwelling therefore on the South American *Utricularia montana*, whose bladders form little subterranean cisterns for the capture of minute terrestrial creatures, the Brazilian *Utricularia natumbifolia*, an aquatic plant, but only growing in the water which collects at the bottom of the leaves of a large Tillandsia, the runner by which, as well as by seed, it propagates itself, being always found directing itself towards the nearest Tillandsia; or the Brazilian *Genlisea ornata*, where the adaptation of means to an end is far too complex for me to describe in brief limits, we will proceed to the Nepenthes, and Sarraceniaceæ, which like the Utriculariæ are differentiated by the absorption of putrid matter rather than by the true digestive processes of Drosera, Dionæa, and Pinguicula.

The Nepenthes or pitcher-plants, inhabitants of the tropical parts of India, Australia, and the Seychelles, partake, however, apparently of both characters. The leaves of this plant form themselves into the most graceful urns and Etruscan pitchers, which are at once traps, reservoirs, and organs of digestion. Some rest upon the ground, others are balanced in the air at the end of long twisted footstalks. To complete the likeness this leafy pottery bears to the work of men's hands, they possess a delicate hinged lid sometimes closing the orifice, sometimes half open, and sometimes thrown back as if merely to attract attention to the opening. In the latter case, not having to serve as a bait, the lid has no nectar-secreting glands; but in the other cases the interior surface of the lid and throat is covered with glands that secrete a sweet fluid to attract the prey to the mouth of the pit of destruction. Below are two distinct zones, the upper one smooth, slippery, and glandless, where the unfortunate insect realizes the truth of Artemus Ward's remark that, when any one takes to going down hill, all things are greased for the occasion, and the lower aqueous zone, where multitudes of minute glands exude a limpid liquid, into which the insect ultimately slips. Inorganic matter produces no effect on the glands, but the presence of organic matter causes the glands to secrete more rapidly; and the action of the fluid on white of egg or meat being the same in character as the secretion of Drosera, though far feebler, would seem to indicate that it performs some digestive function.

This function disappears in the Sarraceniaceæ, which, it has been suggested, might be designated putrivorous plants in contradistinction to the strictly carnivorous plants with the digestive apparatus, since the former only absorb putrid matter. The representative type of this order, the Sarracenia of Linnæus, a native of Carolina, is a marsh plant like Dionæa, with no apparent stem, the leaves forming curious trumpet-like shapes, tapering towards the base, the posterior lip of the wide orifice running up into a tongue-like vertical process. Mistaking it for a lid on the authority of the celebrated botanist, Morison, Linnæus and his disciples fabled that it closed the orifice in hot weather so as to prevent the evaporation of the water contained in these leafy cornucopiæ, and which he contemplated as a kindly provision the great Mother had made to quench the thirst of little birds. Alas for this amiable teleology! More recent observations, especially the careful researches of Dr. Mellichamp, an American botanist, conducted especially on the *Sarracenia variolaris*, in which the orifice of the trumpet is always closed by a lid-like process, and guided by the suspicious circumstance of the accumulation of putrid and decaying animal matter always found in their leafy formations, have proved not only that the liquid of the reservoir is not rain-water, but a vital secretion from the plant itself; but also that it acts as a strong anæsthetic on living flies, and after death produces rapid putrefaction. After half-a-minute's immersion in this terrible bath they appear to be dead, but if rescued recover in from half-an-hour to an hour's time. From the rapid putrefaction of their remains, Dr. Mellichamp concludes that the fluid is not digestive, an opinion in which Sir Joseph Hooker coincides, while confessing the utter ignorance of science as to the way in which the plant absorbs the quantity of decaying nitrogenous matter with which it elaborately manures itself, and which must pass into its system through the tissues of the leaf instead of by its roots.

But whatever obscurity still rests on this point, one point is at least clear that Linnæus' benevolent drinking fountains are in reality perfidious traps. Nectar-secreting glands stud not only the orifice of the trumpet, but both sides of a winged membrane which runs along the whole face of it, so that the unsuspecting insect is conducted by a double "primrose path of dalliance" to the mouth of the pit. Within, conical shaped hairs pointing downwards form a velvet carpet for the descending feet, but turn into a wall of bristling spears the moment the insect attempts to retrace its steps. Below this again the slippery surface forms a glissade, and lastly in the gulf itself, into which the victim is precipitated, long stiff downward pointing hairs converge and intercross, like pitiless arms outstretched on all sides to sink the drowning creature deeper and deeper in the deathful waters.

Yet even in the face of all this apparatus of death, the entomologist Charles Riley tells us there are some creatures that turn the tables and prey upon the formidable plant. A tiny caterpillar spins delicate threads across the orifice, so saving many an insect from the fatal consequences of its insatiable love of sweets, while it devours the outer tissue of the plant. And a large bustling diptera resembling our common bluebottle penetrates with impunity right into the precincts of death, and deposits its voracious larvæ in the midst of the putrid mass, which, when they have exhausted their stolen larder, fall upon one another, the strong devouring the weak, and in this admirably direct way securing the survival of the fittest.

It will be seen in this brief survey of this comparatively recently discovered region of vegetable physiology that much remains to be discovered and still more to be accurately defined. Judging from some researches of Mr. Darwin's on saxifrages, primroses, Pelargonia, and other plants with glandular hairs, proving their powers of absorbing nitrogenous matter, further investigation will elicit some interesting results.

Two points which have doubtless already suggested themselves to the reader remain to be touched upon however briefly and imperfectly. The first is that, in studying such marvellous contrivances as those we have passed in rapid review with all their complex adaptation of means to an end, we are forcibly impressed with the sense of the inadequacy of any natural law at present discovered to account for their existence, and are driven irresistibly into recognizing a creative intelligence at work. Accepting the law of natural selection along its broad lines, and recognizing in it one of the greatest onward steps of modern times to a truer understanding of nature, in applying it to such complex contrivances as these we have been studying, we are met by two apparently insurmountable difficulties. Natural selection can only act by preserving the slight modifications of structure which prove useful to the organism in the struggle for existence, accumulating slight advantageous differences till they result in important modifications of structure. But some of the complex mechanisms we have been reviewing can only be useful to the organism in their last and highly elaborated phase. In Dionæa, for instance, its power of catching a fly depends upon the rapidity with which the lobe closes, and the precision with which the marginal spikes touch and intercross. The first slow beginnings of movement, the first faint approximation of the lobes, would be of no use whatever to the plant. By what agency then is this endless flight of useless steps leading up to the useful result preserved? Certainly not by natural selection, as that by its very definition is only the survival of the serviceable, of that which is of immediate advantage to the plant in the struggle for existence.

Again in Dionæa, and in a less degree in its aquatic representative Aldrovanda, we have to meet the fact that both are apparently dying out. Granting for a moment that they could have been gradually developed from the action of the environment on the organism, it is difficult to see, as all sorts of small flies, or crustaceans are grist to their mill, what change in conditions persistent and strong enough to bring such complex mechanisms into existence, should now cause these same conditions to be too weak and intermittent to perform the inferior task of preserving them. "Final causes" may be and probably is only an expression of our ignorance; but still it seems better to stick to an expression of our ignorance than adopt an inadequate cause, the symbol not of ignorance but of falsity.

The second point which has also doubtless forced itself on the attention of the reader in reading of so many perfidious contrivances is the difficulty of resisting an impression of the cruelty of Nature. It certainly is startling to find her adopting the worst and most cruel inventions of man; and it is difficult to prevent a feeling at times that when studied in detail she witnesses rather to an evil than a good intelligence. This difficulty, which when resolved into its constituent elements is none other than the old original difficulty of the existence of pain and death, I fear must remain a difficulty till we reach a world where space has four dimensions, and where inextricable knots, so plentiful in this world, are mathematically impossible. But let us at least be careful not to enhance the difficulty by unconsciously importing into it considerations and feelings and relations drawn from a higher plane of existence; true in that higher plane, but false in a lower one. In that sleeping and dreaming world of plants and animals that never wakes to moral consciousness, there is, properly speaking, neither treachery nor cruelty, nor love nor hate, any more than a door is cruel that slams upon one's finger, or a slippery stone is treacherous because one trips and breaks one's leg. And as to the amount of pain inflicted on the insect world—death from asphyxia is as merciful as the ordinary slow death from cold and starvation. The only insurmountable difficulty would be the presence in Nature of gratuitous and purposeless pain. But at least Darwinism has helped us here, showing us the purpose which the struggle for existence with its interminable conflict and death subserves in working out the good of the race and the survival of the fittest.

May we not say that in the discovery of flesh-eating plants we have made one more step towards linking animal and vegetable life together into one chain of being, and grasping the unity of plan impressed on the work of one supreme creative Intelligence who

> "of one stuff made us all,
> Baptized us all in one great sequent plan,
> Where deep to ever vaster deep may call,
> And all their large expression find in man?"

And in this constant suffering and dying that others may live and gain fuller completion, may we not find some faint shadowing forth of the great law of sacrifice, which Christianity reveals as the very life of God, and the realizing of which is the highest life of man?

ELLICE HOPKINS.