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And, whence it slept,
Like a swift sword unsheathed,
The lightning leapt,
And round him its fierce arms of flame enwreathed.

The rending throes
Of earthquake, to and fro,
From their repose,
Rocked the perpetual hills, or laid them low.

And still he stood,—
For the vexed planet still,
Created good,
Was whole, and held her course, and had her will.

Around him cloud,
Pale specter of spent storm,
Clung, like a shroud,
And veiled awhile the inviolable form.

But umpire Time,
Serenely wise and just,
With slow, sublime,
Unalterable decision, and august,

Cleansed this away,
And, lo! the glorious front,
In candid day,
Resumed, with solemn joy, its ancient wont.

INSECTIVOROUS PLANTS.

THE strong interest felt by the popular mind in scientific research is becoming every day more and more manifest. Since the publication of Darwin's last book on "Insectivorous Plants," one man, if no more (so the London newspapers tell us), has driven a thriving trade by selling on London Bridge the *Drosera rotundifolia*. So long as the sundew was a common sundew and nothing more, it had to submit to be treated as an insignificant weed; but when its merits as a carnivorous plant were made known, it acquired new dignity and interest.

When the millennium comes, perhaps we shall find that the powerful instinct which prompts us in these evil days to pry into our neighbors' affairs and so do incalculable mischief, has its legitimate satisfaction in exploring the wonders and mysteries of that humble life about us, which has no hidden anguish to cover with smiles,—no closeted skeleton to conceal.

The distinguishing feature which characterizes modern science is not so much that she reaches out toward the new, the wonderful, the beautiful, and brings it within the ken of her few chosen votaries, as that she is penetrating downward into the popular heart and mind, unraveling the golden mysteries of truth for us who are not her high priests, but are only of those who stand humbly afar off and desire to know. There is a wonderful leveling power in the forces at work in modern society. The truth given to the world nearly twenty centuries ago has a secular as well as a religious side to it. Not only have the poor the gospel preached to them, but this same gospel has opened a way through the otherwise impenetrable darkness of human sin and degradation for other light to shine. The dawn of modern civilization which broke upon the Judean hills eighteen hundred years ago is "shining more and more unto the perfect day." Then the great wall of partition set up by man's pride and dogmatism received the blow which shook it to its foundation, and it has ever since been crumbling quietly away.

Now that scientific truth is working its way downward and permeating all classes of society, some slight disturbance is naturally created;—a little knowledge is truly a dangerous thing, not because it is knowledge, but because it is so little. And yet even this little has its use,—it is essential as an entering wedge for more. Darwin, whose name is the battle-cry of one of the opposing forces, is a man possessing such qualities of mind as might well be imitated by those who denounce him as the prince of atheists. He is an observer of facts, who is able to brush away from before his eyes the mists of traditional belief, who looks right into the heart of physical truth, and sees things as they are. There is frequently a judicial fairness about his statement of such facts as strongly militate against his own theory, which is beyond all praise. Where the issue should be made with him is in the magnitude of his inferences. However strongly we may and do dissent from his conclusions,—taken as a whole,—we cannot do less than make grateful acknowledgment of the treasures of fact which he has given to the world. The invectives hurled at his head by the "Christian world" are not arguments, and they have lost their power as mere anathemas. They look far more like the passionate protests of a subtle unbelief, trying to prop up its wavering faith by the violence of its expression, than the calm utterances of a truly Christian faith.

To Darwin, certainly, we owe much of our knowledge of those plants which may be called with perfect accuracy, insectivorous, and to him, therefore, we make acknowledgment.

The pitcher plants and the Utricularias, as we have seen, derive their nutriment from organized matter, by absorbing the results of its decomposition. The plants now to be considered are higher in the scale of being, they possess organs for a true digestion and assimilation, and exhibit, in addition to these peculiarities, other phenomena which have been supposed to be confined to the animal world.

The first of these plants which may be called truly insectivorous is a tiny aquatic plant found in Europe, Asia, and Australia; no mention is made in Darwin's book of any American variety. A search of many days through a number of botanical periodicals has brought to light no single fact in addition to what Darwin has recorded. The botanists all seem to be on excellent terms with the Aldrovanda; they allude to it in their classifications, and use it as illustration with an

FIG. I. DROSERA ROTUNDIFOLIA. [AFTER LINDLEY.]

easy and off-hand familiarity which is very tantalizing to one who is seeking information; but, with the exception of Cohn and Darwin, they tell us absolutely nothing about its life-history.

According to Darwin, then, and to Cohn, the Aldrovanda is a water-plant, destitute of roots and floating freely in its native element; the petioles, or leaf-stalks, grow out radially from the stem; these are broad, and terminate in from four to six slightly divergent spines, each tipped with a stiff bristle. The leaf grows in the midst of these projections; it is bilobed, and the two lobes stand apart about as far as the two valves of a living mussel-shell. The hinge of the two valves is the midrib, and this projects somewhat beyond the leaf itself, and is also armed with a bristle. When the two valves are opened and pressed flat, the impression to the eye is of two circles so cutting each other that the circumference of each passes through the center of the other. The midrib forms the common chord which subtends the four arcs. The overlapping portion of the circles is seen to be darker than the other, and between these two parts of each lobe there is a wide difference of structure and function. The darker segment of each lobe possesses the digestive and muscular apparatus of the higher species of insectivorous plants, while the lighter crescent-shaped portion is covered with absorbent quadrifid processes with which we have already become familiar in the Utricularias.

It is certainly very wonderful that we should find in an obscure and insignificant plant like the Aldrovanda, on one tiny leaf, a perfect representative of each of the two kinds of carnivorous plants, with the peculiar and delicate apparatus of each for the appropriation of organic matter. The Aldrovanda supplies the link between the two distinct modes of nutrition in this class of plants, as the class supplies the link between the two great kingdoms of organic nature. The absorption of decomposed matter, performed by the quadrifid processes on the outer portion of the leaf, has already been described in the case of the Utricularia. The digestive process of the glands upon the inner portion will appear as we study the Drosera and Dionæa, to which it bears a close resemblance, especially to the latter. Indeed, Darwin speaks of the Aldrovanda as a miniature aquatic Dionæa.

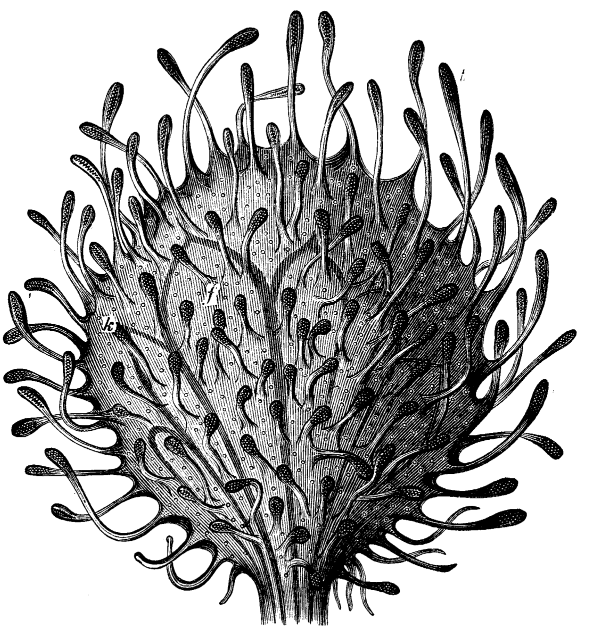

FIG. 2. LEAF OF DROSERA ROTUNDIFOLIA (EIGHT DIAMS.) [FROM NATURE.]

The Drosera rotundifolia [Fig. 1], or sundew, is a common weed, found in poor and peaty soil which can sustain only the sphagnum mosses, and such vegetation as derives little nutriment from the soil. It bears from two to six leaves, which generally spread out radially and horizontally from the base of the flower-bearing stem. The leaves, which are rounded and slightly concave, are covered on the whole upper surface with what appears to be glandular hairs, each of which bears upon its tip a drop of dew. The leaf itself and its pedicel are green; these hairs, or tentacles [*t*], as Darwin calls them, from their resemblance in function to the tentacles of polyps, are of a purple color. On the central portion of the leaf, or disk, the tentacles are short, and stand upright, and their pedicels are green; toward the edges they become longer, and they are more inclined outward, and their pedicels are purple. On the extreme margin they are still longer and bend backward. [See Fig. 2.] *

The tentacles are not like ordinary trichomes or hairs, which, as we have seen, belong to the epidermal system, but they seem to be prolongations of the leaf itself. Bundles of fibro-vascular tissue extend from the leaf up into the tentacles, and in the glandular swellings at the end a bundle of spiral vessels may be very easily seen under moderate powers. The glands, except those borne by the marginal tentacles, are oval [see Fig. 3], about $\frac{4}{500}$ of an inch in length, and of about equal size. They are composed, as the drawing shows, of a bundle of spiral tissue surrounded by several layers of cells, the inner ones decidedly elongated. These spirals are not air-conducting passages, as is usual, but secretory vessels, it would seem, though not essential to the performance of this office, as they are wanting in the glands of some other genera of the Droseraceæ. The marginal tentacles differ somewhat from the others in having elongated glands and in being less irritable, though they do not show any essential variation. The whole leaf, above and below, is covered with small trichomes having a cone-shaped pedicel surmounted by two, three, or four

* Figs. 2, 3, 5 and 6 were drawn from preparations supplied to me by Dr. G. D. Beatty, and Figs. 7–10, by Mr. L. R. Peet, of Baltimore.—S. B. H.

rounded cells, containing much protoplasm. These papillæ [Fig. 2, *p*] do not secrete, but they absorb readily, and aid in the assimilative process of the plant.

If a small object be placed upon the center of a leaf, an impulse is transmitted radially to all the tentacles; the nearer ones are first reached, and begin slowly to bend toward the center, afterward those farther away are similarly affected, until, finally, every one of the hundred or more tentacles of the leaf closely clasps the object. This inflection takes from one to five hours or more for its completion; the difference in time depending upon many circumstances,—on the vigor and age of the leaf, on the size and nature of the object, on the temperature of the air, and upon the present condition of the leaf in consequence of a recent inflection.

If the glands be repeatedly touched, if drops of certain fluids are placed upon the disk, or if it be immersed in certain solutions, inflection is induced. In bending over to clasp an object, the marginal tentacles—which normally bend backward—sometimes sweep through an arc of 180°. The whole tentacle does not bend, but only a portion of the pedicel just above the base. When an object, which excites the leaf to become inflected is placed in the center of the disk, the short middle tentacles do not move; if, however, it be placed to either side of the medial line, they bend over toward it and clasp it. If a nutritious object be placed upon one of the marginal glands, or an insect alight there, that tentacle alone bends, till the captive is deposited in the center of the disk, and then a radial impulse is sent out which causes all the tentacles of the leaf to bend over and clasp it. The object, it will be understood, is held fast by the viscid secretion of the glands.

Not only do these tentacles themselves bend over, but when any strongly exciting liquid like milk is placed upon the middle of the disk the whole blade becomes incurved and forms a tiny cup. At times the edges curve inward and upward equally all around, but usually the apex and two sides turn upward forming a triangular vessel. The time during which a leaf remains incurved, or the tentacles remain inflected over an object, depends somewhat upon the vigor of the leaf, and the temperature of the weather. But by far the most influential force in determining this time, is the nature of the object causing inflection. If the captured prey is capable of yielding nutriment to the plant, the leaf remains much longer inflected than when the object is innutritious. After an interval of from one to seven days the tentacles re-expand and the leaf is again ready for action.

The natural prey of these leaves are, of course, insects, though they may be fed with meat, albumen, drops of various liquids, such as strong infusions of raw meat, cabbage, peas, etc., and they have been known to die of something akin to dyspepsia, from partaking of too much cheese. Every gland is surrounded by a drop of a viscous pellucid substance which it secretes; the heat of the sun, which dries the drops of genuine dew, has no effect upon this secretion unless it be to induce a freer flow. To this fact the plant owes its popular and poetic name of sundew. Any insect which chances to alight upon the gland-bearing leaf is caught and held fast by the viscid secretion, and its fate is sealed; as soon as it is fairly clasped by the incurved tentacles, the glands pour forth a new secretion, which closes the spiracles and the victim dies. This second secretion, as we shall see, differs very much from that which secured its prey, for it is a true digestive fluid.

Any minute particle of matter, which penetrates the viscid secretion, and comes into actual contact with the gland produces inflection, but unless it touches the gland itself, no effect is produced. If a gland be touched once or twice with considerable force, the pedicel does not bend; repeated touches, however, even when lightly made, produce inflection. Though the feet of the most delicate insect, after resting for a few moments on the gland, cause the tentacle to bend over, repeated drops of rain, it is found, induce no movement.

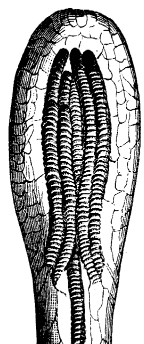

FIG. 3. TENTACLE OF D. ROTUNDIFOLIA. (100 diams.) [From nature.]

A very curious interior molecular movement so generally accompanies inflection that it will not be out of place to mention it here. When the motor impulse is communicated to the bending portion of the pedicel of a tentacle, and inflection begins to manifest itself, a change takes place in the cells—a change which is clearly manifest under a low power, and may even be detected by the naked eye. Previous to the excitement of the tentacle its cells seem filled with a homogeneous purple fluid; sometimes not more than ten seconds after excitation, the cells of the gland become cloudy. Under a very high power, this change is seen to be due to the fact that small purple granules appear within each cell which aggregate into minute spheres, and these, in their turn, coalesce into larger masses of purple protoplasm, suspended in a colorless fluid. These protoplasmic masses are continually changing shape, dividing and coalescing, and spontaneously moving. If the excitation of the gland has been very great, the aggregation extends down through every cell of the tentacle; during this process the steady flow of a protoplasmic current, before described as cyclosis, goes on around the inner surface of every cell wall. The stimulants which produce inflection also induce aggregation; $\frac{1}{134,400}$ of a grain of the carbonate of ammonia administered to a gland has been known to produce distinct movement and aggregation.

The effect is the same whether the gland be excited directly by repeated touches, or by the presence of an exciting body, or indirectly, by the transmitted impulse from other and distant glands. The exciting influence which produces inflection can not be identical with the direct cause of aggregation; because, even when the impulse comes from another part of the leaf, and the motor power must run up the tentacles to which it is transmitted, the aggregation invariably begins at the cells of the glands and runs down. As long as the tentacles remain closed aggregation is present; when they re-expand, the little masses of protoplasm dissolve, and the cells seem again filled with a homogeneous purple fluid. As this curious effect may be induced by the presence of bits of glass, etc., it is, of course, entirely independent of absorption. "Physiologists," says Darwin, "believe that when a nerve is touched, and it transmits an influence to other parts of the nervous system, a molecular change is induced in it, though not visible to us. Therefore it is a very interesting spectacle to watch the effects on the cells of a gland, of the pressure of a bit of hair, weighing only $\frac{1}{78,700}$ of a grain, and largely supported by the dense secretions; for this excessively slight pressure soon causes a visible change in the protoplasm, which change is transmitted down the whole length of the tentacle, giving it at last a mottled appearance, distinguishable even by the naked eye." The leaves of Drosera detect with the utmost quickness and the most unfailing certainty the presence of nitrogen. At the time when this power was discovered by Darwin, the delicacy of the test was unrivaled. Now he says with a little crestfallen air: "The spectroscope has altogether beaten Drosera," for it can detect the presence of $\frac{1}{200,000,000}$ of a grain of iodine,—while Drosera could do no more than announce the $\frac{1}{20,000,000}$ of a grain of phosphate of ammonia.

When any substance yielding nitrogen is placed upon the Drosera disk, a liquid is secreted and poured out over it from the glands, which differ from the drops already formed upon its surface. This change in the quantity and quality of the secretion is effected in all the glands before the outermost ones have been fully inflected; it is, therefore, not the direct result of absorption, but of a transmitted influence. Physiologists tell us that when the stomach of an animal is mechanically irritated, it secretes an acid; but that it does not secrete its proper ferment, pepsin, till the absorption of certain nutritious substances has taken place. The experiments upon Drosera show a precisely analogous process. As soon as the glands are excited, an acid is secreted; but it is only after absorption that the true gastric fluid makes its appearance. That this secretion "contains a ferment which acts only in the presence of an acid, on solid animal matter," as animal pepsin does, has been clearly proved. While the process of digestion by the leaf, is going on, the addition of a minute portion of alkaline matter is found to arrest it at once; while the addition of acid sets it going again.

The identical substances are found to be acted upon, in the same way and to the same degree, by the gastric fluid of Drosera, as they are by animal pepsin. Cartilage, bone, even the enamel from teeth, were experimented upon, and it was found were dissolved by it, as well as certain vegetable substances, such as the stored-up matter of living seed, pollen-grains, and the fragments of seedlings. Various experiments were made by Mr. Darwin to ascertain the effects produced by different salts. He found that $\frac{1}{20,000,000}$ of a grain of phosphate of ammonia caused a marginal tentacle to sweep through an arc of 180°. The sensitiveness, in this case, is greater than that found in the most sensitive organs of the human body. Many curious facts came to light under this close investigation. Camphor, it was found, is a violent stimulant; the poison of the cobra occasioned only slight protoplasmic changes, while liquid alcohol produced no effect whatever. In small doses the fumes of camphor, alcohol, and chloroform, threw the plant into a stupor. Carbonic acid is also a narcotic, which fact offers a curious confirmation of the lately determined point that plants exhale, *as the result of true respiration*, the same gas as is given out by the breathing of animals.

The sensitiveness of the Drosera leaf appears to be wholly confined to the glands. Unless the gland which is excited be upon a a marginal tentacle, the object, or touch, that induces its own inflection also causes a radial influence to be sent outward from its base as a center that affects, first, the nearest tentacles, and in succession, those which are farther and farther off. This impulse does not follow the fibro-vascular bundles, whose arrangement may be seen in Figure 2, *f*; but its course seems to be determined by the form and position of the parenchymal cells of the base of the tentacles themselves and the surrounding tissue. The cells are elongated in the pedicels of the glands; they are arranged radially about the bases of the tentacles, and are longer in the longitudinal direction of the leaf. Aggregation may be seen to be obstructed by every cross-division of the cell wall; the motor impulse is probably hindered in the same way, for it always travels most quickly in the direction where there is the least obstruction in the form of cell walls.

When the bending portion of a pedicel receives the impulse from its own gland, it always becomes inflected toward the center of the leaf, and so all the glands, if immersed in any exciting fluid, turn toward the center. When, however, the exciting substance is placed on any other portion of the leaf, the motor impulse is so transmitted radially from the point touched that all the glands turn toward it as a center. The motor impulse, as it ascends the pedicels of adjacent tentacles, immediately acts upon the bending portion without first ascending to the glands, and then being transmitted downward. Some other impulse is, however, transmitted to the glands, for they begin secreting an acid substance, and the glands send back toward the bases of the pedicel that subtile force which induces aggregation. This is the only case of anything analogous to the reflex action of the nerve centers of animals known in the vegetable world.

The mechanism of the movements is not well understood; while the tentacle is bent—and it has been made to curve around a complete circumference—no folds or wrinkles can be seen in the concave portion of the bending part. It is known that when inflection takes place, a portion of the fluids belonging to the cells in the concave side goes over to the convex. It is supposed that the molecules of the cell walls on the concave side of the pedicel undergo a process not unlike that of the aggregation of the cell contents.

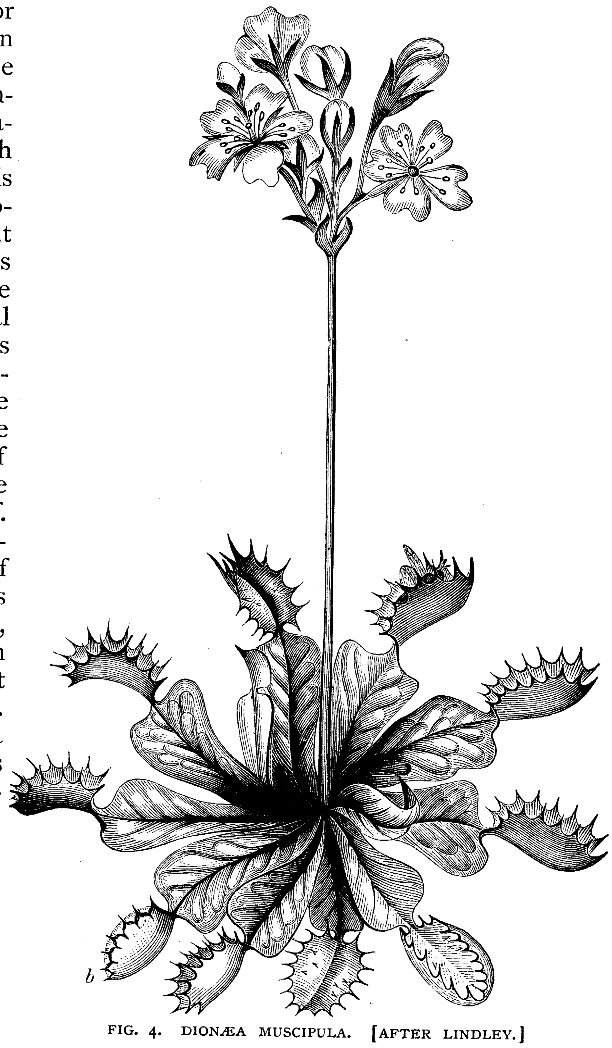

FIG. 4. DIONÆA MUSCIPULA. [AFTER LINDLEY.]

The many experiments made upon the Drosera lead to the conclusion that its tiny rootlets perform for it only the office of imbibing moisture, while its food is in part

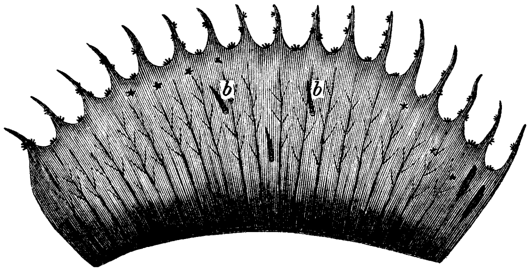

FIG. 5. LOBE OF DIONÆA.

supplied by the atmosphere, and in part by the animal matter it truly digests.

There are a number of other varieties of the Droseraceæ. One, the *Drosera binata*, is an Australian plant, and has leaves which, with their footstalks, measure twenty-seven inches in length. True to its Australian traditions, it differs greatly from its foreign cousins. There are perfectly developed tentacles on the back of the leaf, which are capable of secretion, absorption, and aggregation, but not of inflection. On both surfaces of this variety are well-developed sessile (seated) glands, which secrete only after the absorption of some nitrogenous substance. This variety forms the connecting link between Drosera and Drosophyllum, possessing the organs of both.

The Drosophyllum has been found, so far, only in Portugal and Morocco. The leaves are narrow, concave above, and several inches long. They are covered with stalked, mushroom-shaped tentacles, and quantities of small round, or oval, sessile glands. Internally the tentacles and glands are alike, but they are fitted to perform entirely different functions. The tentacles have no power of flexure; the substance which they secrete, unlike that of Drosera, is easily detached from the gland, and for that very reason is specially adapted to its peculiar mode of capture. The two secretions,—of the viscid acid and of the pepsin,—which in Drosera are performed successively by a single gland, are performed in Drosophyllum by two separate organs,—the mushroom-shaped tentacles secreting the first, and the sessile glands the second of these fluids. The latter glands secrete spontaneously their peculiar sub-

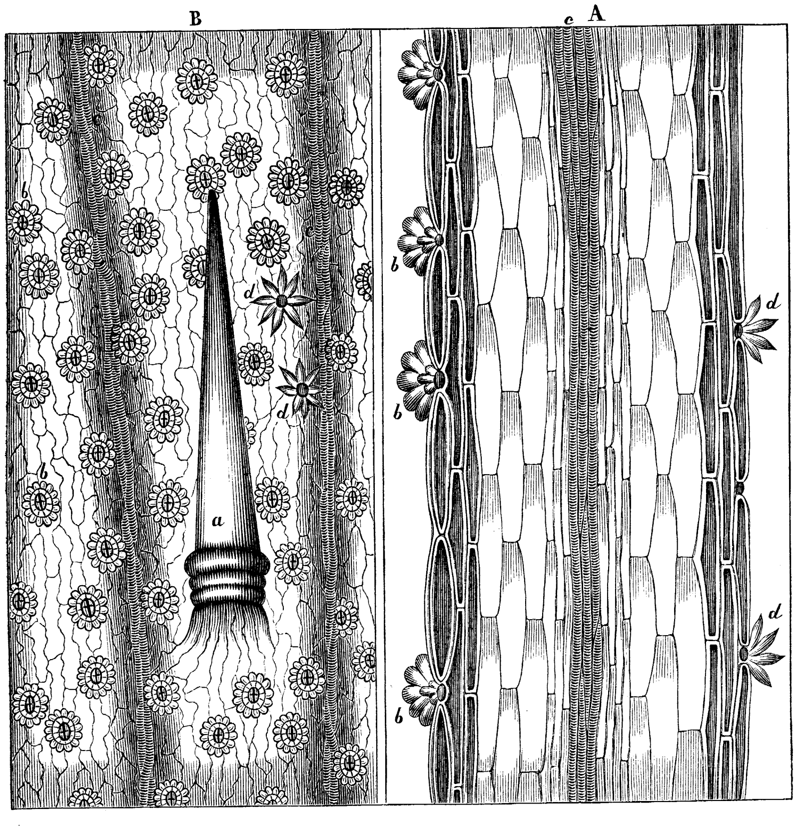

FIG. 6.

A, Glandular texture of Dionæa leaf, seen in section; *b, b*, glands on upper surface; *d, d*, stellate hairs on lower surface. (About 150 diams.) B, Glandular surface of Dionæa leaf, seen from above; *b*, digestive glands; *d*, stellate hairs; *a*, sensitive filament. (100 diams.) [After nature.]

stance, which is sufficiently fluid to roll off their rounded tops at a touch. An insect alights, and rolls off, carrying with it the viscid drop which effectually clogs its wings and legs, so that it lies helpless upon the leaf below. The lower glands, now, being

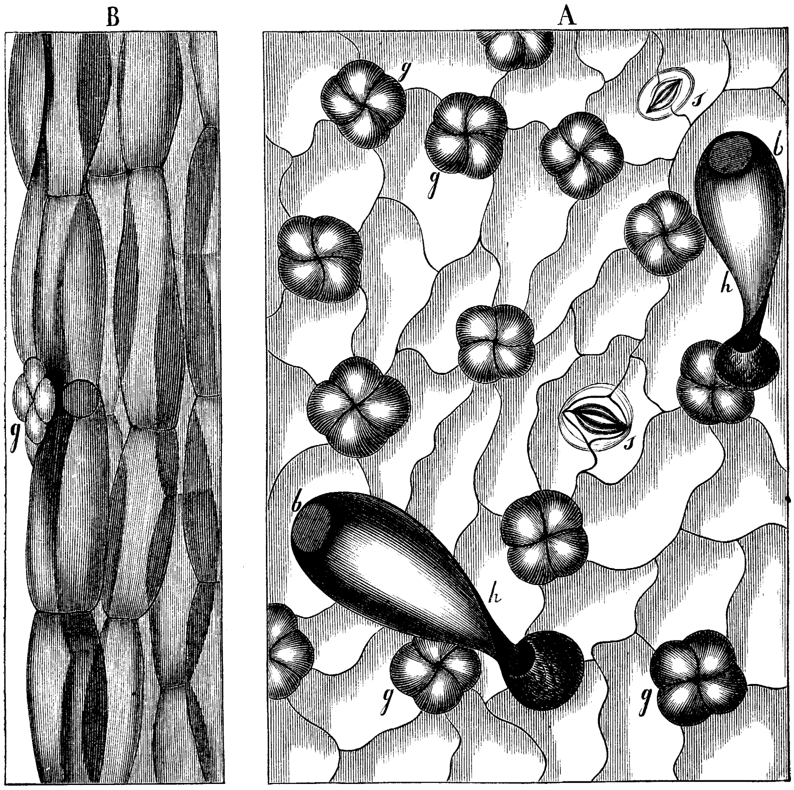

FIG. 8.
A, Pinguicula glandular surface of leaf; *g*, glands; *h*, hairs; *b*, base of hairs; *s*, stomata. [From nature.]
B, Section of Pinguicula leaf; *g*, glands. [From nature.]

excited by the presence of nitrogenous matter, begin to secrete their pepsin, and the food is finally digested. The gastric fluid secreted by all of the Droseraceæ, it may be mentioned here, is an antiseptic,--the substances submitted to its action always disappearing, as they do in animal pepsin, without showing any signs of decomposition.

The Dionæa, or Venus's fly-trap, is found in great quantities in parts of this country. It presents many points of similarity, and as many of difference, when compared with Drosera. [See Fig. 4.] It possesses, like the Drosera, very small roots. As the plant has been successfully grown in wet moss, they probably serve the same purpose, and are useful only for imbibing moisture. The footstalk broadens out into a leaf-shaped expansion of tissue, *a*, *a*, *a*, at the end of which a two-lobed leaf is found. The lobes curve upward and outward convexly, at an angle of less than 90° from each other; the lobes terminate on their outer edge in a row of sharp projecting points, into each of which a bundle of spiral vessels extends. On the upper surface of each there are three delicate filaments, triangularly placed. [See Fig. 5, *b*, *b*; also Fig. 6, B, a.] Occasionally there are more or less; but the usual number is three. These filaments seem to be the only sensitive part of the lobes; through their sensitiveness they show, not by their own movements, but by that of the lobe on which they are placed. The upper surface is thickly covered with glands, sessile upon the leaf, with a convex

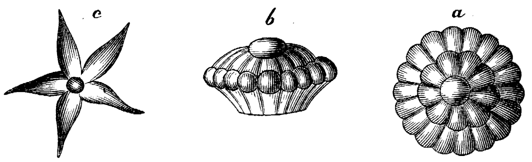

FIG. 7. GLANDS. [AFTER LINDLEY.]
a, top view; *b*, side view; *c*, stellate hairs.

upper surface. [See Fig. 7, *a*, *b*; Fig. 6, A, *b*, B, *b*.] These glands secrete, but only after having absorbed some nutritious substance.

Minute projections, having eight arms, stellate hairs, are found thickly studding the outer surface of the lobes. [Fig, 6, B, *d.*] The whole processes of movement and digestion are wonderfully and beautifully correlated. The continued pressure, however slight, which causes the slow inflection of the Drosera tentacles, after the first touch, has no effect upon Dionæa. The Drosera captures its prey by means of its viscid secretion, and the pressure caused by the struggles of the insect causes inflection, which it accomplishes quite at its leisure. Dionæa, having no secretion, secures its prey by instantly closing upon it. The filaments, therefore, which cause the lobes to close instantly at the lightest touch, are comparatively indifferent to prolonged pressure. These filaments have nothing whatever to do with the digestive process; they are merely the sentinels, on guard to signal at the approach of a victim.

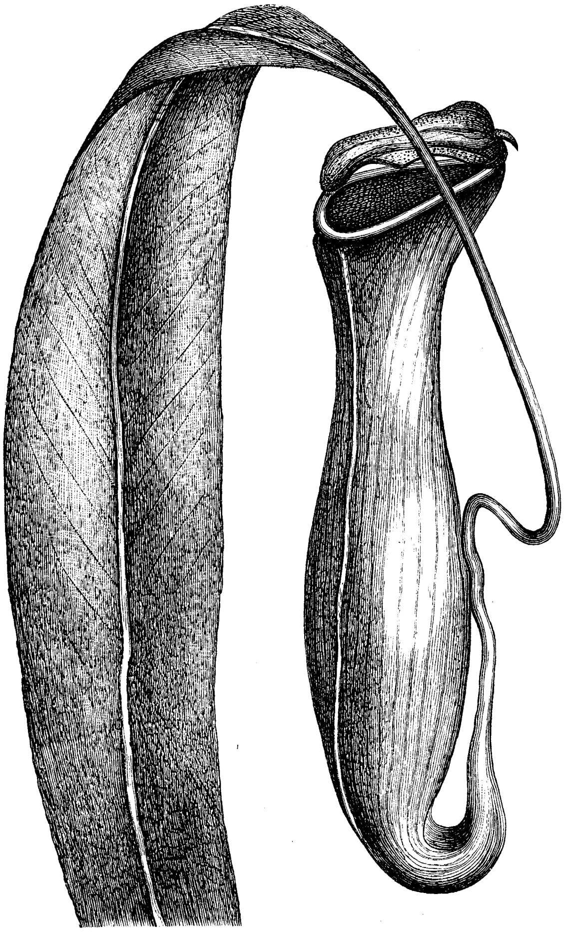

FIG. 9. NEPENTHES DISTILLATORIA.
Leaf and pitcher, natural size. [From nature.]

Inorganic bodies placed upon the lobes, unless they touch the filaments, do not cause them to close; organic bodies when moistened and placed upon the leaf cause it, after absorption has taken place, to close slowly. The lobes may be made to close over either organic or inorganic matter, but with a difference. When an inorganic substance is placed upon the leaf and the filament touched, the leaf closes leaving a hollow chamber, the spines crossing and interlocking as in Fig. 4, *b.* When, however, an inorganic substance is placed upon the leaf, both lobes press against it and against each other, through their whole extent, with a force sufficient to perceptibly flatten a cube of the white of hard-boiled egg, upon which they have shut. A corresponding projection may be plainly seen on the outside of the lobes after they have fairly closed over their prey; no secretion takes place unless absorption begins. When a substance possessing no nutritious properties is inclosed, the glands are not excited to secretion, and the lobes soon re-open, disclosing the object perfectly dry. If they close over a very minute organic object, it is allowed to escape between the interlocking teeth, —the play, Dionæa thinking, not being worth the candle. When, however, the organic object is large enough to be worth their while, the lobes flatten themselves against it, the spines standing upright and parallel instead of interlocking. The glands touched by the nitrogenous substance begin to secrete as soon as absorption has taken place. The digestive fluid containing the nitrogenous matter is then forced by capillary attraction up between the flattened lobes so closely pressed together; in this way, all the glands are excited to secretion—and the prey is digested. The two movements induced by a touch upon the sensitive filaments and by secretion, are very wonderful in their entire adaptiveness to the purposes which they subserve. A touch from any useless substance, unless it chance to be upon one of the sensitive filaments, produces no effect, while the presence of a nutritious one on any portion of the leaf causes it to close. After a short interval, with no exhaustion of the gastric fluid, the leaves unclose, unless they have captured something which will help to maintain life, while they remain closed over nutritious matter, instead of twenty-four hours as Drosera, for fifteen, twenty-four, or even thirty-five days. The power of secretion and absorption belongs to the sessile glands [Fig. 6, A, *b*, B, *b*] which are an epidermal outgrowth, and whose appearance under the microscope as the focus is slowly changed is strongly suggestive of their being morphologically stomata, which have been modified to subserve another purpose.

In most cases when the Dionæa lobes re-open after their meal they are torpid, and no excitement of the glands or filaments is sufficient to induce movement. In this respect it differs greatly from Drosera, which is quite ready for another meal before its tentacles are fairly re-opened.

The transmission of the motor impulse in Dionæa is very rapid; a touch upon any one of the six filaments causes both lobes to close at once and simultaneously. The bending portion of the lobes is situated just above the midrib. Many beautiful and delicate experiments, made by Mr. Darwin, go to show that the curvature of the lobes is due to the contraction of the upper superficial layer of cells. The movement of these leaves is due to the same cause, at work in the contraction of the muscular tissue of animals. In both cases, a normal electrical current exists, which is disturbed upon any irritation of the organism. The Aldrovanda, of which mention has been made as a sort of aquatic Dionæa, has upon the inner digestive portion of its leaf, numerous sessile glands which assimilate food, and double-jointed, sensitive filaments which enable it to close upon its prey.

The Pinguicula, or common butterwort, offers one or two points of interest, as an insectivorous plant. A stem, bearing a cluster of purple flowers in general appearance very much like the sweet violet, springs from a rosette-like cluster of radical leaves. It bears about eight rather thick, oblong, light green foliage leaves, which when young are deeply concave. The margins of the leaves are much incurved, and their upper surfaces are studded with glands *g*, stomata *s*, and extraordinary vase-shaped hairs *h*. [Fig. 8.] As in the other insectivorous plants, the roots are short and few in number. The principal point of interest about this plant is that it appears to derive more nutriment from vegetable organisms,—from seed, spores, pollen grains, and even minute seedlings, which are found adhering to its leaves,—than do the other members of the same family. In a paper published in 1847, by Planchon, in the "Annales des Sciences Naturelles," the writer brings together almost every recognized species of the insectivorous plants, mentioning them by name, noticing the fact of their secretions, and power of inflection, but never hinting at the fact that they appropriated the nutritious qualities of the insects they captured. It seems marvelous that an observer who could have noticed the obscure structural resemblances which bind these widely separated species together, should have overlooked the fact that they were insectivorous, especially when he himself supplies the clue to this discovery in the statement that the Lapps use the Pinguicula leaves to coagulate their milk, which causes it to set in a firm, sweet curd. This, it is very well known, is usually effected by rennet, a preparation made from the stomach of the calf, which of course contains animal pepsin.

The most beautiful of all the second class of this group of plants, is the superb Nepenthes, or pitcher plant of the East. [Fig. 9.] At the end of the true leaf there is a prolongation of its midrib, which sometimes grows to the length of a yard and bears upon its termination a vase-shaped growth. This pitcher is, according to Hooker, an enormously developed gland, like those which in a less conspicuous form are formed upon the tips of many leaves. In *Nepenthes am-*

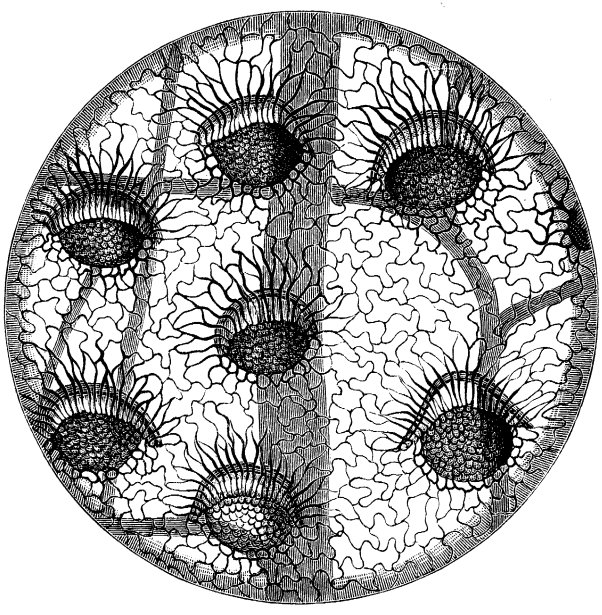

FIG. 10. NEPENTHES DISTILLATORIA.
Glands in stomach part of pitcher. (80 diams.)

pullaria they attain to the height of eighteen inches—and the corrugated brim extends inside in the form of projecting incurved spines, which are strong enough to prevent the escape of any unwary bird which may thrust itself into the cavity in search of food. It would be hard to imagine anything more wonderful and beautiful than the shape, the marking, and the coloring of this graceful pitcher—the broad corrugated brim flares off in a brilliant shaded rose-colored rim, bordering its whole mouth. Down the

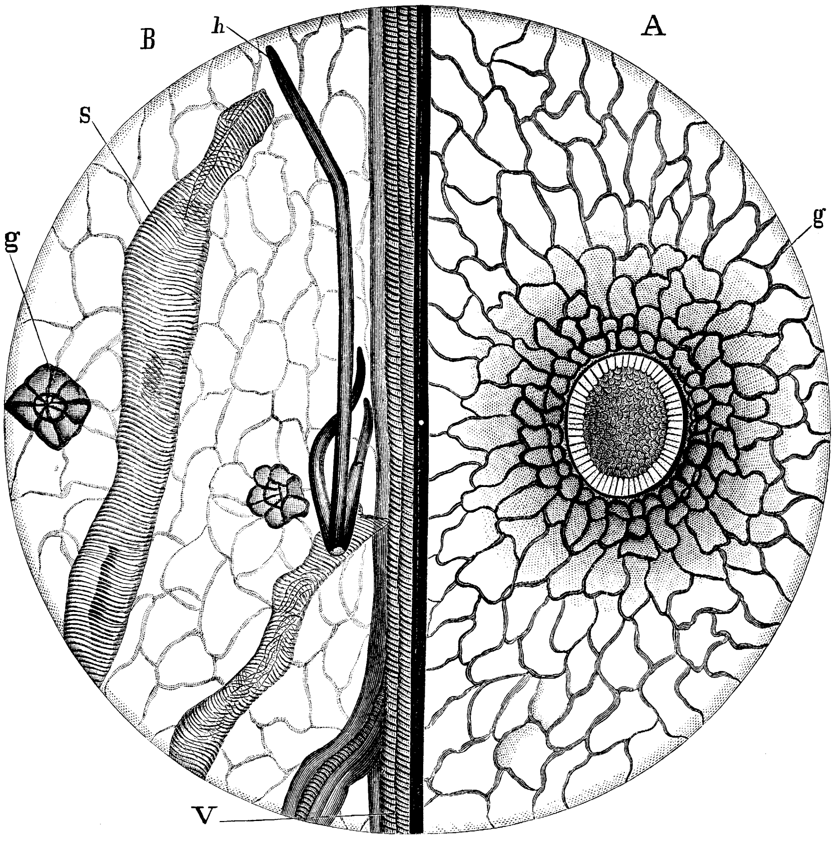

FIG. 11.

A, Single large gland, on upper and inner surface of pitcher of N. distillatoria. (250 diams.) [From nature.] B, same surface; V, veins of leaf, with spirals; *s*, apparently spiral vessel; *g*, glands (honey glands); *h*, branching hair on external surface. (250 diams.) [From nature.]

front run two fringed longitudinal wings, and above it stands a graceful leaf of brilliant colors, which sets off jauntily from the opening as if it had accepted the position, but had no notion of doing the work, of a vulgar lid. The inner surface, as in the Sarraceniaceæ, is divided into several portions, the attractive [Fig. 11], containing the honey glands; the conductive, being, according to Hooker, smooth and glassy, and covered with minute reniform excrescences; and the secretive, which is studded with innumerable glands of a very curious shape. [Fig. 10.]

Fig. 9 is a much smaller variety than the gigantic *N. ampullaria* described above. It is the *Nepenthes distillatoria*, a native of China, and kindly sent to me by Mr. Smith, of the Botanic Gardens, Washington, D.C. The drawing is life size, and the magnified pictures, Figs. 10 and 11, were cut from this identical pitcher. An attempt was made to prepare one of the hundreds of ants which it was in the process of digesting, but the chitinous coats of even those which were most perfect had been made so tender by the gastric fluid as to drop to pieces with a touch. The enormous crater-like gland, Fig. 11 A, was the only one found on a number of pieces cut from the upper portion of the pitcher. The branching hairs B, *h*, glands *g*, *g*, and curious spirals, *s*, seen in the figure occur over the whole of the attractive surface. The secretive, or digestive glands, Fig. 10, are large enough to be seen by the naked eye, as tiny specks regularly dotting the internal, lower surface of the pitcher. They all looked fairly brown with the insect remains they had accumulated or digested.