"INSECT-EATING" PLANTS.

SINCE the appearance of Mr. Charles Darwin's book upon this subject some few years ago, the theory of carnivorous or insectivorous plants has created a great deal of interest in the scientific world. A short time afterwards another English botanist published a series of fresh observations, which greatly added to our knowledge of these singular plants. The idea, however, was not of recent origin, and botanists who have taken up this interesting subject are well aware that the foundation of all researches in this direction was laid by Ellis, an English *savant* of the last century, who published his researches as far back as 1768, in which year he informed Linnæus that, according to Bartram the traveller, the Dionæa muscipula, a plant growing in North Carolina, was insectivorous. He also communicated to the illustrious Swede his own observations on the irritability and prehensile movement of the leaves of this Dionæa, properties which had never hitherto been observed to exist in the vegetable kingdom. In communicating these details to Linnæus, Ellis gave it as his opinion that the plant not only caught and killed insects, but actually fed upon them. This idea was corroborated some sixty years after by an American observer (the Rev. Mr. Curtis), who

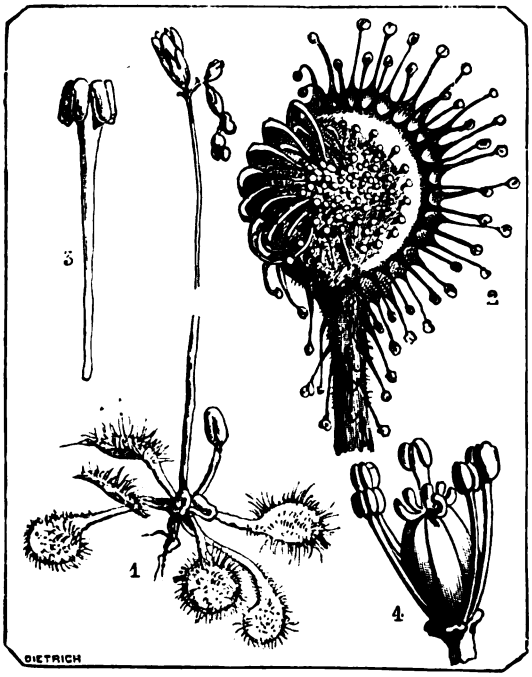

Fig. 1. Drosera rotundifolia (Sundew).—1. The entire plant. 2. A leaf enclosing in its tentacles an insect placed in the centre. 3 and 4. Structure of the stamens and ovary.

published his observations on the wild plants growing in the marshy prairies of North Carolina in 1834. He remarked that under the irritation caused by the feet of the insects, the two lateral portions of the leaf on each side of the midrib approached each other suddenly and crossed the stiff hairs growing on the edge of their upper surface, and that independent of the act of capture, the leaf exuded a mucilaginous substance, which completely covered the insect, causing it to dissolve and disappear through its corrosive action. Curtis, however, made no converts to his theory, which was treated with incredulity by the naturalists of his day, and it is only since Darwin revived the subject that scientific men have taken any real interest in it. The publication of his researches brought the Venus's Fly-trap into such favour that nurserymen found it difficult to satisfy the demand, and the spongy prairies of North America were ransacked to supply the wants of eager experimentists all over the world. The experiment was simple enough to come within reach of any one. It was merely necessary to place a fly or any animal matter on the upper portion of the leaf in contact with the six little cones with which it is provided, when the two sides of the leaf immediately closed over the intruding body. Following in the wake of Darwin, botanists fed their Dionæas to repletion on flies and other animal food, and the enthusiasm of many of his admirers soon carried them far beyond their masters. Professor Balfour went so far as to declare, that when a toothsome morsel was presented to the leaf its mouth watered, so to speak, the secretion being greatly increased in quantity; while Mr. Canby stated seriously that a forced diet of cheese was prejudicial to the Dionæa's system, causing a veritable nausea. The force of enthusiasm could no further go, and the opinions just cited brought about a healthy reaction. Observers began to look about for other plants giving evidence of these natural miracles, as Linnæus called these singular phenomena. Those small and delicate plants, too, known as the Sundews (fig. 1), bear leaves whose upper surface is covered with glandular hairs of a sufficiently complex structure to be considered as part of the leaf itself. Towards the end of the last century a German botanist pointed out that the leaves of the Sundew were capable of catching insects that alighted upon them, and these members of the Droseraceæ were placed in the rank of carnivorous plants. As in the case of the Dionæa muscipula, flies and pieces of meat are seized and dissolved in a few hours. The glandular processes of the leaves being the main agents in capturing and retaining the insect or scrap of meat, the attention of botanists was more especially directed to those Sundews. The Pinguiculas (fig. 2) of our peaty meadows also belong to the class of insect-eating plants. Their fleshy leaves are covered on the upper surface with hairs, some of which are sessile, while others are pediculated, their summits being crowned by a glandular process, formed of radiating cells, not at all unlike a small Mushroom. The following interesting description is from the pen of M. Edouard Morren:—"A small fly, attracted probably by the glutinous appearance of the leaves of the Pinguicula, foolishly alights on one of them. From that moment his fate is sealed. He finds himself captured by the feet, which stick fast to the glutinous and downy surface. He struggles in vain to regain his liberty, and even if he succeed in loosening one of his feet, the others stick all the faster. He wears himself out in his vain efforts to escape, and, speedily resigning himself to his doom, falls motionless on his side in the saliva-like liquid, which gradually works into his body, and the poor insect dies a lingering and painful death in the course of several hours. When at last death takes place, the body of the fly is but little altered in shape and roundness, but the next day it begins to flatten, and seems to be glued still more firmly against the leaf, until at last it appears to be incorporated with it. In two or three days almost all vestiges of the insect disappear, nothing being left but the skin." Thus far M. Morren; but our researches ought to be extended further, and all plants provided with leaves in the form of receptacles, or whose surface is glandular, ought to be received into the class of carnivorous plants requiring supplementary nourishment. An American observer, amongst others, put forth the opinion that the Utriculariæ were insectivorous plants. The singular structure of their bladders has been the object of constant investigation; here and there at the base of the ramifications of the bladders are little vesicular bodies, which are divisions of leaves transformed into vesicles, as has been proved by M. Duval Jouve. Every one of these little organs is hollow like a sack, its contracted neck being closed by a lid, over which is a crown of leaf-like segments, or a little ring of hairs to guard the aperture. "These bodies," says M. Duchartre in his "Eléments Botaniques, "play a physiological part, which increases our interest in them. First of all, they are full of a gelatinous liquid, which is sufficiently heavy to keep them at the bottom of the water, but a short time before the flowering season sets in the aerial canals of the stem convey air to the subaqueous parts of the plant, which, being rootless, rises to the surface of the water and throws out its flowers. The flowering time ended, and the fruit having nearly attained a state of perfection, the air disappears from the interior of the bladders." The transverse blade with which the orifice of the vesicle is furnished, closes it like a valve, and is capable of opening and shutting both inwards and outwards when it is compressed. It is then that the water by which the plant is surrounded forces it downwards to the bottom of the marsh or piece of water containing it. It has been observed that when the cover of the bladder is open, or forced apart by an insect or crustacean, it is impossible for the animal to escape, so that the interior of these vessels always contains the organic remains of putrefied insects, which apparently help to feed the plant. The genus Aldrovanda, the only known species of which is an aquatic plant, one variety of which is found in the stagnant pools of the south of France, is regarded as possessing the same properties, although there is no trap, as in the case of the Utricularia; but it must nevertheless be remarked that in both cases the breaking up of the tissues of the animal is performed by the glands with which the walls of the flower are covered, and that absorption of animal matter takes place. "Thus," says Darwin, "every ordinary plant that is provided with viscous glands which accidentally catch insects may, under favourable circumstances, become changed into a species capable of digesting truly." From the Utricularia, an aquatic plant (which is not, it is true, endowed with powers of movement like the Dionæa, but which is provided with its peculiar sacks or vessels), to aërial plants provided with apparent pitchers there was but one step, for analogy of form seemed to presuppose analogy of function. Plants bearing these receptacles were consequently immediately put under contribution, and Dr. J. D. Hooker, in a remarkable discourse, described his observations on the Sarracenias and Nepenthes. There are but few collections of plants, whether private or public, which do not contain representatives of these two genera. The Sarracenias are plants growing in the marshes of North America, of which the species S. purpurea is the most commonly cultivated. Their leaves, through an anomaly of development, increase in size at an early stage on the outside of the rim, so that they gradually grow into a boat-like form. According to M. Baillon, the leaves of the Sarracenia are almost peltate at the time of their development, but gradually fold their edges over until they assume a tube-like form. The form of this tubular leaf may be imitated by drawing the leaf of a Nasturtium through a small tube by means of the petiole. As for the formation of the pitchers of the Nepenthes, Dr. Hooker has already given us a long account of it, and it results from his observations that the urn of the Nepenthes, instead of being the leaf itself, is a gland situated at the apex of the inner surface of the leaf. This supplementary organ increases in size, the parts become distinct, and the pitcher and its cover are gradually formed. The urns of the Sarracenia Drummondi and S. Darlingtonia are often of great capacity, and in some cases hold as much as 8 or 9 fluid ounces. The Nepenthes are rather more difficult to cultivate than the Sarracenias, owing to their habitat being within the tropics. Their urns are frequently varied in structure, according to the species. Certain of them have pitchers over 1 ft. long, and streaked with different colours. Their edges are often provided with stiff hairs, sometimes even with thorns, the point of which are directed inwards and downwards. The back part being very smooth, we have all the conditions necessary for an efficient trap from which escape is impossible. These urns normally contain a liquid which is said to be secreted by the inner surface of the pitchers; one thing, however, is certain, that the moisture of the air, that of a hothouse, for instance, is condensed and stored up within these receptacles. The presence of insects in these urns, a fact which had been observed by many travellers, was readily taken advantage of by Dr. Hooker, who subsequently proved that the introduction into the urn of inorganic matter produced no appreciable effect, although a piece of animal matter immediately determined a considerable increase in the amount of liquid. He also proved that out of the urn the liquid produced but feeble signs of having digestive properties, while in the interior animal substances were rapidly and completely digested. The Sarracenias and Nepenthes may therefore be considered as belonging to the class of insectivorous plants. The only species of Cephalotus (C. follicularis—Labill.), is a pretty little plant belonging to the Saxifrages. It bears gracefully-formed urns provided with covers, with wings covered with hairs, which curve elegantly outwards from the pitchers. No experiments appear to have been made on this plant, or if they have they are unknown. M. Lemaire, however, in an article on this plant, states that the urns, like those of Sarracenias and Nepenthes, contain a liquid in which large numbers of insects drown themselves. In the Dionæa we have two phenomena which are sufficiently remarkable: the first is the irritation which the mere touch of a fly's feet produces on one of the six glands which are on the upper surface of the leaf; the second, the fact that wind and rain have no action on these glands, except water be projected on them sideways with a certain degree of force. M. C. de Candolle, who has studied the structure of these glands, states that they are formed of the parenchyma of the leaf being one with deep tissues, and that they are not like ordinary hairs, a mere epidermic production. If the epidermis of the leaf be excited, no effect takes place. As soon, however, as the glands are touched, no matter how lightly, the effect is immediately perceptible. This action is immediately communicated to all parts of the parenchyma of the inside of the leaf, which is immediately affected throughout the whole of its interior. Various writers have tried to explain this excitement by the tension and turgescence of the tissues. It is a well-known fact that vegetable cells while growing are provided with a thin skin which is perfectly closed, but which nevertheless has the power of absorb-

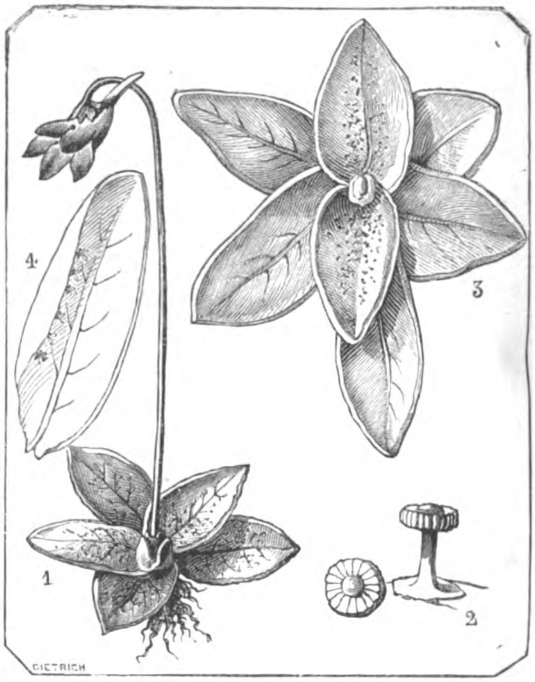

Fig. 2. Pinguicula vulgaris (Butterwort).—1. The entire plant. 2. Large glands placed on the upper surface of the leaf. 3. Leaves in the form of a rosette, containing the remains of an insect. 4. Leaf, the edge of which has shut over an insect.

ing through its walls the gases and liquids by which it is surrounded; but whether from the immaturity of the cell, or from some other reason which need not be inquired into at the present moment, the younger cells seem capable of absorbing liquid more rapidly than their older neighbours. This phenomenon has been studied in the Sensitive Plant by M. Paul Bert, and M. C. de Candolle explains the phenomena taking place in the Dionæa by supposing that the turgescence of the upper layer of the parenchyma of the leaf suddenly ceases when the glands become excited. The upper layer of cells becoming flaccid, the leaf naturally curls inwards like a piece of damp paper held before the fire. On the other hand, the lower surface is alone provided with stomata, and the turgescence of this portion of the leaf is not in equilibrium with that of the upper surface. It follows that the leaf already has a tendency to roll itself. It must also be borne in mind that the valves of the leaf shut in the evening like those of the Sensitive Plant. Be this as it may, we are still perplexed on some points after all those remarkable researches, and even authors themselves acknowledge that there are many difficulties to be cleared up before arriving at the truth. How, for example, is such rapidity of movement effected? Is not the instability of the tissue affected the real cause of the movement? As yet we have no satisfactory answer.

We now come to the question of the absorption of animal matter by these plants. M. C. de Candolle affirms that for six weeks he has fed Dionæas on flies and other insects, morsels of beef, white of egg, &c., side by side with others which have received no animal food, but that he could perceive no difference in the health or appearance of any of the plants. The Drosera has been extensively studied by M. Edouard Morren. Here the conditions are somewhat different. The glands with which the upper part of the leaf is furnished secrete a viscous liquid with an acid reaction. Animal matter is therefore attacked and disintegrated by this liquid, which, in some respects resembles animal gastric juice. The slow movement which is produced in the hairs or tentacles of the leaf from without inwards, whenever a piece of animal matter is presented, would favour the supposition that the plant really requires animal food. The hairs, having bent inwards upon the animal substance with which they have been irritated, remain in perpendicular contact with it, covering it with their acid, viscid secretion. A few hours later on, the albuminous portions of the animal matter become transparent, its angles disappear, and after a day or two but little traces of it are left. What seems so singular is the preference which the tentacles appear to possess for animal matter, while to paper, wax, Elder pith, or any other non-azotised substance, the tentacles appear utterly indifferent; indeed, in some cases the tentacles have been known to bend away from the objectionable object. Mr. Darwin in no way doubts that the glands, which possess the property of dissolving azotised matter, are at the same time organs of absorption. This illustrious naturalist sees the proof of this function in the fact, that azotised matter, especially carbonate of ammonia, induces the aggregation of protoplasm of the upper cells of the tentacle, but the action of ammonia on all plants has long been patent to the whole world. It has also been satisfactorily proved that ammonia is absorbed by the leaves of most plants, especially certain species of Bromeliaceæ, which have no roots. The acid liquid secreted by the leaves is stated by Dr. Frankland to contain either propionic or valeric acid. That there is an absorption of azotised matter there can be no reasonable doubt. One chemist fed a Drosera on flies which had been soaked in chloride of lithium, and several days after found traces of that rare metal in all parts of the plant. According to MM. Edouard Morren and Duval-Jouve, the animal matter presented to the Pinguiculæ, Utriculariæ, and Aldrovandæ goes through all the stages of putrefaction, such as the formation of putrefaction, ferments, mycelia of fungi, bacteria, and mycoderms of various kinds. The action of the viscid liquid, however, manifests itself on the albuminous portions of the animal matter, giving them a transparent appearance that seems to indicate the beginning of solution. One of the arguments which militate most in favour of the theory of carnivorous plants is offered by the fact, that animal matter placed on the leaves provided with glands is preserved for a much longer period than if it were to be placed on an ordinary leaf of the same plant. At a late meeting of the French Botanical Society, when this question was brought forward by M. Heckel, a member observed that there was nothing wonderful that an acid liquid, whether a glandular secretion or not, should preserve animal matter from putrefaction any more than that sound vegetables should be kept free from taint by being immersed in vinegar; but we must also recollect that all acids are not antiseptic in their properties. M. Duval-Jouve, in a most conscientious spirit, has done all in his power to glean the truth from a large number of often contradictory observations made by distinguished naturalists. He has partly refuted the observations concerning the absorptive powers of the glandular surface of the Utriculariæ and Aldrovandæ, for the reason that these glandular surfaces are to be found on all parts of the plant, and that one part cannot be more absorbent than another. Considering all that has been done by a multitude of observers, we are obliged to acknowledge that the first arguments drawn from them went a little too far, while those radical naturalists who totally deny that carnivorous plants exist at all are just as intemperate on the other side. The question of absorption is the true point in dispute. We must not, therefore, be surprised if we find the statements of observers on this point to be often contradictory, more especially as a certain amount of divergence of opinion still exists with regard to the absorptive functions of ordinary leaves and roots. The Sarracenias and Nepenthes have not given rise to so many bitter disputes as the Dionæas and Droseras, owing to the absence of the acid secretion, and their claim to a place amongst insectivorous plants has had but few adherents. The liquid they contain is neutral to test paper, and can hardly prefer

Fig. 3.—Arum Dracunculus (one-third the natura size).

a better claim to being considered a fly-trap than an ordinary bottle half-filled with water. If we once take away the qualification of insectivorous from fly-catching plants, we may at once increase the class beyond all bounds, and the Silene Armeria, Lychnis viscaria, Physianthus albens, Apocynum androsæmifolium, some species of Erica, and several others, must all be classed amongst carnivorous plants. The Aristolochia Clematitis imprisons any fly that may enter its bell until fecundation has taken place. Certain of the Aroids, the Arum Dracunculus (figs. 3 and 4), for instance, are most efficient fly-traps. In Arum Dracunculus, the phenomena are somewhat complex. The inflorescence is trumpet-shaped, is 10 in. or 11 in. in length, and 5 in. or 6 in. across the mouth. The livid tint of the inside of the spathe, which is of a dark violet, and the strong and disagreeable odour which it emits, attract flies in swarms; besides this, the interior surface of the spathe is lined with hairs hooked at the end. The strong smell seems to act as a narcotic on the flies, and they die suffocated either by the odour or a certain amount of carbonic acid gas which these flowers produce while in blossom. M. Daveau, of the French Botanical Society, describes two other plants which have never hitherto been considered to be fly-traps, but which have some claim to be placed in that category. One of these is the Mentzelia ornata, one of the family of the Loaseæ, a native of Texas (fig. 5). It bears a yellowish-white flower measuring about 3 in. across. The whole of the plant, with the exception of the petals, is rough to the touch; this is due to the leaves and stems being thickly covered with hairs of a peculiar structure, as shown at A, fig. 5, but more especially on the outer surface of the receptacle. All the Loaseæ are provided with these hooked hairs, which sometimes have stinging properties, having a bulb at the base containing an acrid liquid like the ordinary Nettle; these hairs, although harmless to man, are fatal to insects. The hairs growing on the Mentzelia, which are not stinging, are shown at A, fig. 5; unlike the urticating hairs on other members of the Loaseæ family, they are solid, and provided with a number of curved barbs; between these barbed hairs are shorter ones with a soft bulb at the top; this bulb exudes a viscid substance, having a peculiar odour very attractive to flies, which endeavour to taste it by inserting their probosces between the barbed hairs in order to taste the bait. Having sipped their fill, they endeavour to withdraw their probosces, which are immediately pierced by the barbs on the hairs. The insect gradually tries to escape by pulling and twisting his proboscis in all directions, generally leaving his head behind him in his frantic efforts to release himself. If a plant of this species be examined on a fine sunshiny day, the outside of the receptacle is generally found to be partially covered with the heads of flies which have decapitated themselves in their endeavours to escape. Even the smaller diptera do not escape, for the viscid matter of the smaller hairs is of so glutinous a nature that they cannot withdraw their proboscis, and perish as miserably as their larger brethren. These plants, although most effective fly traps, can hardly be called carnivorous, or even insectivorous. Another example is afforded by one of the Asclepiads, Physianthus albens, which, according to M. J. Belleroche, a Belgian botanist, performs the same office on butterflies, the trap being this time in the interior of the flower. The Gronovia scandens is one of the Cucurbitaceæ, and a native of equatorial America (fig. 6). It is a climbing plant, giving out numerous stems, the stalks and leaves being covered with long, strong, flexible hairs, each terminated by a couple of claws, like those of a cat, which lay hold of everything that touches them. In the Jardin des Plantes, in Paris, several of these plants are cultivated under glass in a hothouse, which is much frequented by small lizards on account of the warmth, but whenever they venture to climb on the Gronovias after the flies, which form their natural prey, the claws of the long hairs described above enter the interstices of the lizard's scales, and effectually imprison it. The large lizards generally manage to escape, but the smaller ones often fall victims to their temerity. M. Daveau has counted as many as seven dead bodies in a single day on one plant. The lizard figured in the cut when measured was found to be 4 in. long.

Fig. 4.—Section of an Arum flower, in the interior of which are several captured flies.

After the facts cited above one can hardly decide peremptorily on the value of Darwin's theory without assuming a great responsibility. However this may be, it is certain that the observations made during the past few years are frequently contradictory, and that the advocates of the carnivorous or insect-eating theory have been but too frequently carried away by their enthusiasm. It is to be hoped that the researches which are now being carried on by so many naturalists will throw a true and strong light on these mysterious phenomena of vegetable life.—" La Nature."