

DARWIN'S INSECTIVOROUS PLANTS.*

THAT certain plants, many of them of a common or homely kind, have the power and the habit of catching insects by means of a sticky secretion given out by their leaves or tentacles, has been from time immemorial a fact widely known amongst observers of nature. Of plants thus endowed the most familiar is the common sun-dew (*Drosera rotundifolia*) of English heaths or downs. Others amongst the Droseraceæ were observed to have more or less the same habit of retaining insects, as had also numberless other vegetable forms possessing a viscid secretion, such as the horse-chestnut. That this habit was connected, in the case of certain special plants of the order, with a power of digestion and assimilation—the plant deriving its nourishment therefrom as truly as any form of animal life does from the digestion of its food—is one of the most recent as well as the most startling additions to our knowledge of natural history. What chiefly led to this remarkable discovery in botany was the observation of the plant known as Venus's flytrap, or *Dionæa muscipula*, a member of the limited family of Droseraceæ, found only in damp places in the eastern part of North Carolina. At home, however, the attention of Mr. Darwin had been drawn fifteen years ago to the large number of insects which were caught by the leaves of the sun-dew upon a heath in Sussex. That insects were so caught he had often heard, but he knew nothing further about the matter. Since that time, however, he has set himself to accumulate facts bearing upon this interesting subject; and the result of his observations, combined with what has been contributed by the research and thought of other scientific labourers in the same field, is to be seen in the volume recently put forth, which marks an important advance in the development of the physiology of plant life.

The general aspect of the sun-dew, with its glandular filaments or tentacles, two hundred or so in number, covered with a viscid secretion glittering in the sun, must be well known to observant dwellers in the country. Mr. Darwin's opening description gives ample details of its inner structure and physiological action, of the cellular tissue of which the glands are made up, and the fluid secretion which they give forth. The mode in which these tentacles are affected by the contact of various objects—paper, bits of glass, wood, cinders, or chemicals, and especially of organic bodies such as bits of meat, or living things such as insects—gave Mr. Darwin scope for long and minute experimental observation. Insects are in general killed in something like a quarter of an hour, their trachea being closed by the sticky secretion, which is slightly antiseptic. They are clasped by the tentacles, and carried in a period varying from ten to forty-eight hours to the central vascular orifice or stomach, where they are gradually absorbed as protoplasm and merged in the substance of the plant. It is owing to its being thus nourished by the absorption of animal matter from captured insects that drosera is able to flourish upon extremely poor peaty soil, in some cases where nothing else grows but sphagnum moss, depending, as all mosses do, upon the atmosphere for nourishment. Although, from the fact of the pedicels of the central tentacles as well as the petioles containing chlorophyll, it is clear that the plant obtains and assimilates carbonic acid from the air, nevertheless, considering the poverty of the soil whereon it grows, there can be no doubt that the supply of nitrogen would be extremely limited, if not wholly wanting, had not drosera the power of obtaining this important element from captured insects:—

We can thus understand how it is that the roots are so poorly developed. These usually consist of only two or three slightly divided branches, from half to one inch in length, furnished with absorbent hairs. It appears, therefore, that the roots serve only to imbibe water; though, no doubt, they would absorb nutritious matter if present in the soil; for, as we shall hereafter see, they absorb a weak solution of carbonate of ammonia. A plant of *Drosera*, with the edges of its leaves curled 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, differently from an animal, it drinks by means of its roots; and it must drink largely, so as to retain many drops of viscid fluid round the glands, sometimes as many as 260, exposed during the whole day to a glaring sun.

Before the experiments made by Mr. Darwin no such power as that of true digestion was known to exist in the vegetable kingdom. The most weighty and interesting chapter of his book is that in which he establishes by careful experiment and induction the fact that the leaves of drosera have the power not only of dissolving animal matter and reducing it to protoplasm, but of digesting the matter thus reduced, which is absorbed by the glands and incorporated with the tissues of the plant. It was found that nitrogenous fluids acted on the leaves of drosera differently from non-nitrogenous fluids, and that the leaves remained clasped for a much longer time on various organic bodies than on inorganic bodies, such as bits of glass, cinder, wood, &c. The irritation set up was consequently more than a merely fibrile, if not merely mechanical, one, such as that of the mimosa, or so-called sensitive plant. Following up this phenomenon, the question arose, could the leaves not only absorb matter already in solution but render it soluble—that is, had they the power of digestion? This process, as is well known, is effected in animals by means of a ferment, pepsin, together with an acid—generally weak hydrochloric acid—neither pepsin nor the acid having by itself this power. Now when the glands of the disc in drosera

were excited by the contact of any object, especially one containing nitrogenous matter, it was found that the outer tentacles and often the blades of the leaf became inflected, the leaf being converted into a temporary cup or stomach, the discal glands at the same time secreting more copiously, and the secretion becoming acid. These glands, moreover, were seen to transmit some influence to the glands of the exterior tentacles, causing them to pour forth a more copious secretion, which also became acid, or more acid than it was before, as tested by litmus paper. On presenting various substances it was found that they were acted upon precisely as they are by the gastric juice in the higher animals. In the case of albuminous substances the secretion similarly lost its power when neutralized by an alkali, recovering it when an acid was added. Like the ferment in animals it appeared to be antiseptic, arresting the discoloration and decay of substances such as the white of egg, cheese, &c., and checking the growth of mould or infusoria. Particles of roast meat were affected precisely in the same way as by the gastric juice. Pure fibrin was completely absorbed, though but slowly, the leaves being imperfectly excited. Syntonin, on the contrary, extracted from muscle, acted quickly and energetically, its presence in raw meat making it even too powerful a stimulant, the leaves being injured or even killed. Areolar tissue was easily and quickly digested by the secretion, elastic tissue and cartilage only in part. Bone was softened and decalcified, and even dentine and enamel were made somewhat tender and flexible. No very energetic effect was produced by gelatine, but it is well known that gelatine has little power of nourishing animals. Chondrin, both in a dry state and liquified, had far more effect. Milk was rapidly coagulated, and so was casein, when in the state in which it exists in milk, but far less so in the state in which it is prepared by chemists—a further point of resemblance to gastric juice. Pollen and gluten, the latter especially when fresh, were quickly and completely digested by the secretion. But many other substances, some of them containing nitrogen, were not in the least acted on by it, and induced inflection of the tentacles no longer than inorganic or insoluble objects. Such unexciting and indigestible substances were those of epidermic origin, like bits of human nails, balls of hair, or quills of feathers, fibro-elastic tissue, mucin, pepsin, urea, chitine, chlorophyll, cellulose, gun-cotton, fat, oil, and starch. To these Mr. Darwin adds dissolved sugar and gum, diluted alcohol, and vegetable infusions not containing albumen, none of these substances exciting the least inflection—a further important proof of the identity of the ferment of drosera with pepsin. A series of elaborate experiments with chemical agents, such as salts of ammonia, or uric, malic, tartaric, and other acids, showed a strong tendency to cause inflection of the tentacles, nineteen out of the twenty-five acids tried acting either rapidly and energetically or slowly and slightly. The acids contained in the tissues of the plant itself may hence be thought to play an important part in their economy. Alkaloid poisons, including strychnine, quinine, nicotine, atropine, theine, curare, morphia, and hyocyamus, together with the cobra poison, were tried with instructive, whilst varying, results. Some of these seem to act on elements in no way analogous to the nerve-cells of animals. Those which affect only nerves connected with the muscles, like curare, colchicine, and veratrine, could not be expected to act on drosera. The venom of the cobra, which paralyses the nerve centres in animals, had no deadly effect, merely causing strong inflection. In other respects a remarkable parallelism is to be traced. Various metallic salts, many of which are highly poisonous to animals, such as those of silver, mercury, gold, tin, arsenic, chromium, copper, and platinum, are equally so to drosera. Not so, however, strange to say, are chloride of lead and two salts of barium. Equally strange is the fact that, though acetic and propionic acids are highly poisonous, their ally, formic acid, is by no means so, and that while certain vegetable acids—namely, oxalic, benzoic, and others—are deadly in a high degree, gallic, tannic, tartaric, and malic (all diluted to an equal degree), are not so, although malic alone of them induces inflection. But a pharmacopœia, as Mr. Darwin remarks, would be requisite to describe the diversified effects of various substances on drosera. Six other species of drosera beside rotundifolia, some of them inhabitants of distant countries, came under Mr. Darwin's observation. Widely as the leaves of some of these species differ in shape, in functional powers they differ very little, all of them being adapted to catching insects by nearly the same means. Two of these, *D. spatulata* and *D. binata*, or *dichotoma*, are from Australia, and one, *D. capensis*, from the Cape of Good Hope. Another Australian species, *D. heterophylla*, is made by Lindley a distinct genus, *Sondera*; but our author has nothing to say of its insect-catching properties, having seen none but dried specimens.

Mr. Darwin's original researches on the power of absorption and true digestion in *Dionæa muscipula*, as well as in drosera, have to a great extent been already made public through the lectures or addresses of Dr. Burdon Sanderson and Dr. Hooker. We have here at greater length, and in their most authentic form, the series of experiments by which the functions of this remarkable plant were for the first time established as a matter of science. The filaments or spicules whereby *dionæa* catches its prey, equally sensitive as they are, and closing with as rapid a movement, have not the same viscid secretion as those of drosera. They interlock on the closing of the lobes, like the teeth of a rat-trap. The upper surface of the lobes is thickly covered with small purplish or reddish glands, the rest of the leaf being green. In these glands rests the power of secretion and absorption, though, unlike drosera, they do not secrete until excited by absorption of nitrogenous matter. Bits of wood, cork, paper, glass, &c., may be left any length of time on the

* *Insectivorous Plants*. By Charles Darwin, M.A., F.R.S. With Illustrations. London: John Murray. 1875.

surface of a leaf, it remaining quite dry. If, however, the lobes close over a bit of meat or an insect, the glands over the whole surface of the leaf secrete copiously. The cells of the glands were found under microscopic examination to bear evidence of the process of absorption, having their contents aggregated in a beautiful manner into dark or pale purple, or colourless masses of protoplasm, these masses undergoing incessant changes of form, sometimes separating from one another and then re-uniting, exactly as in the cells of *drosera*. Herein is seen the preliminary condition of digestion. When a leaf closes over any object it may be said to form itself into a temporary stomach. If the object yields ever so little of animal matter this serves as a peptogene, the glands on the surface pouring forth an acid secretion similar in action to that of the gastric juice in animals. *Dionæa* is not indeed so well fitted as *drosera* for observation, since the process goes on within the closed lobes, and in consequence not so many experiments were tried upon it, but these were amply sufficient to prove that it truly digests. Insects, even beetles, after being subjected to the secretion for several days are surprisingly softened, though their hard chitinous coats are not corroded.

The nature of the sensitiveness possessed by *drosera* and *dionæa*, in common with certain other plants, draws Mr. Darwin's special attention, and is marked out by him for future research. Although the cells of these plants are quite as sensitive to certain stimulants as are the tissues which surround the terminations of the nerves in the higher animals, yet these plants are inferior even to animals lowest down in the scale in not being affected except by stimulants in contact with their sensitive parts. By radiant heat they might indeed be affected, warm water exciting energetic movements. But the motor impulse, however engendered, is transmitted at a far slower rate than in animals, owing doubtless to the absence of nerves. Still more plainly do these plants exhibit their inferiority in the absence of any reflex action save of the most rudimentary kind, and above all in the lack of a central organ able to receive impressions from all points, to transmit their effects in any definite direction, to store them up and reproduce them. Still, that vegetable organisms should so far share functions hitherto supposed to distinguish the animal kingdom as to digest animal matter and to draw nutriment therefrom, is perhaps as remarkable a fact as has ever been recorded in the history of science. It brings another and a most striking illustration of the doctrine of the unity and continuity of nature.

TRAVELS IN PORTUGAL.*

MR. LATOUCHE modestly prefaces his book with an apology for the pretension of his title. When the contents originally appeared in the form of articles in the *New Quarterly Magazine*, he called them simply "Notes of Travel," and even that appears to have been in some degree a misnomer. For, as he travelled with no idea of publishing, he took no memoranda at all, and his book is the fruit of an afterthought and an effort of memory. Notwithstanding that, or possibly because of it, it is a very good one so far as it goes; nor, except that it may have made some of his recollections fainter, do we see that he need plead in extenuation of shortcomings the fact that his riding tour was interrupted by long periods of residence. On the contrary, it is to the deliberation of his movements that he was indebted for an unusual familiarity with the Portuguese and their habits, as well as for his proficiency in a difficult language, in which the visitor should be pretty thoroughly at home if he means to profit by Portuguese travel. The scheme of Mr. Latouche's work is decidedly original, and we wish it were more generally adopted. If he does not avoid the capital and the chief cities, at least he does not dwell upon them. Sometimes he may take advantage of the railway or diligences, but, as a rule, he rides; he sticks to the by-ways in preference to the highways, and sometimes he heads adventurously across country, finding his way through the mountains and the wastes where there is no track of any kind. Generally, of course, he put himself in charge of a guide; occasionally he dispensed with hired companionship, availing himself of the friendly offices of the chance acquaintances he might pick up on the road or at his resting-places. He engaged horses or bought them to sell again. He could make himself very independent of hotel comforts; and it was just as well that he could do so, for in Portugal the inns are few and miserable, and the intelligent traveller must look out for billets as best he may. As is usually the case where strangers are scarce, the natives are inclined to be hospitable, and although they cannot understand that a man should travel for mere pleasure or mental improvement, yet they are flattered by his coming among them and showing an interest in their country. Repeatedly a friendly farmer would insist on taking Mr. Latouche in and making him feast on his home produce and try his wine. Now and then a curé would do the honours of his own parish, and show the way to the next. A man of accommodating temper, frank manners, and an inquiring turn of mind who rides about in that way naturally picks up a great deal of knowledge; and although the plan of Mr. Latouche's movements may have been desultory, he appears to have sampled the country fairly. There is one marked feature in his book—he abstains on principle from dilating on the scenery. It is not, however, that he cannot appreciate it, for in the single exception

which he makes he describes a landscape admirably. But, generally speaking, the country seems to be monotonous. You have careful cultivation in the low grounds, interspersed with patches of scrub or brushwood. You have arid stretches of bare hills and broad extents of dull, waterless woodland. When you do come upon running streams, the timber changes its character, and there are pleasant oases of rich foliage hanging over verdant meadows. But, on the whole, Mr. Latouche's account of the country is by no means encouraging to those who may be disposed to follow in his footsteps. They ought to know themselves, and to reflect whether the game is worth the candle. He warns them that they will have to rough it; he points out that objects likely to be popularly interesting are few and far between, and, as we have said already, he insists primarily on the necessity of the traveller's having fairly mastered the language beforehand. Then there are an infinity of shades of ceremonious courtesy that must be scrupulously observed if you would avoid ruffling the susceptibilities of the natives. It is not as in Spain, where the greater includes the less, and where, if you address everybody as "Your Worship," you may travel through the country without having your manners reflected on. In Portugal, it is true, the ragged boys in the streets style each other "Your Worship" while indulging in the most offensive personalities. But there are at least four separate degrees of address which must be employed discriminatively in communicating with the different ranks of society, from the high-born noble down to the peasant.

Mr. Latouche at his start purchased a horse at Vigo, and struck into the country from the north, entering by the Galician frontier. There the river Minho forms the boundary. The Spanish town of Tuy is almost within a stone's throw of Valença, on the Portuguese bank, but "the inhabitants of either town are in customs, habits, manners, and dress almost as distinct as the people of Dover and those of Calais." There is little or no intercourse between the two, and there never has been much. Where there is a jealous Custom examination, and where papers must be produced before passing the frontier, there can be little opportunity for the acquaintanceships that end in intermarriage. Childe Harold in his time sings of the Spaniard beyond the little rivulet that traces the frontier of Portugal on the east, looking down on "the Lusitanian hind the lowest of the low," and it is certain that that feeling of contemptuous antipathy is still very universal even in Spanish Estremadura, one of the most backward and barbarous provinces in Spain. Mr. Latouche, an impartial observer, unhesitatingly gives the palm of superiority to the Portuguese, where the two races show themselves in contact. "The Portuguese is, at least as far as my observation goes, the better looking, better dressed, and better mannered of the two." He confesses, however, that to the stranger approaching from the north the contrast would naturally be more marked than elsewhere. The Gallengans are among the rudest of the motley population of Spain; it is they who are the drawers of water and bearers of burdens to all the rest of the peninsula, while the *Entre Douro e Minho* is the most flourishing part of Portugal. Mr. Latouche's earliest experiences on horseback showed him how little he could count upon in the way of regular accommodation, and prepossessed him at the same time in favour of the people among whom he was venturing. Towards nightfall he overtook a respectable farmer, and asked how far he might be from food and shelter. The farmer laughed, and assured him his chances were bad anywhere nearer than the town of Viana, which was still distant, but offered to show him the way to a house in the neighbourhood where he might make shift, failing anything better. The house proved to be a favourable specimen of the picturesque residence of a well-to-do farmer. The road that led to it was a rough ox track, but it was carried under the interlacing foliage of oaks and chestnuts, intertwined with trellised vines growing in untrimmed luxuriance. It opened into an outer courtyard, also roofed in with the vine leaves that trailed across from the side walls to the stone pillars in the centre. "It is a private house," exclaimed Mr. Latouche. "It is the house of your Excellency," returned the farmer, courteously uncovering himself, and he invited the stranger in, and gave him of his best. That night's hospitality showed Mr. Latouche more of the habits and ways of thought of the farming class than he would have learned in many days of riding from inn to inn. The fare, if plain, was excellent. It consisted of soup made of beef, bread, and cabbage, and the boiled *bacalhao* or dried codfish, both of which are national dishes, with full-flavoured wine which, judging from the description, must have been a rough but sound natural port. But the way of serving was primitive. There were neither plates nor table-cloth. Each man had his own earthenware bowl and wooden spoon, and when those above the salt had satisfied their hunger, the dishes were pushed down to the servants who sat below. The conversation was at least as piquant as the repast. The host was a strange mixture of shrewdness and simplicity, childishly innocent of the mode of life of other men who lived under different conditions of climate, and profoundly imbued with local superstitions, which he was persuaded to illustrate by stories told in perfect good faith. His farm, like most of those in Northern Portugal, was copyhold. He paid a nominal rent to a landlord who had no power of ejecting him, and he had inherited as eldest son at the death of his father, being responsible for the portions of the younger children.

Riding through a great part of Portugal, you may imagine yourself in some respects transported to Arcadia. It is not only the picturesque meadow-scenery by the banks of the rivers, or the

* *Travels in Portugal*. By John Latouche. With Illustrations by the Right Hon. T. Sotheron Estcourt. London: Ward, Lock, & Tyler.