BOTANY AND HORTICULTURE.

INSECT-EATING PLANTS.

An immense addition to this new and marvellous department of knowledge has just been made in Mr. Darwin's "Insectivorous Plants," in which he sums up the results of some fifteen years of observation and experiment: a contribution to science as noteworthy as his work on "The Fertilization of the Orchids," or that on "The Structure and Distribution of Coral Reefs," works which the most determined adversaries of Darwinism have not presumed to denounce as unscientific. More than half the volume, which comprises nearly five hundred closely-printed pages, is devoted to the study of the common sundew of England, *drosera rotundifolia*. Six other species of drosera from various parts of the world were also brought under observation; also the Venus flytrap (*dionæa muscipula*) of North-Carolina; the aquatic *aldrovanda vesiculosa;* the fly-catcher of the Portuguese, *drosophyllum lusitanicum; roridula dentata,* from Cape of Good Hope; *byblis gigantea,* from Western Australia; several species of *pinguicula,* and a number of *urticularia.* The *nepenthes,* studied by Dr. Hooker, are merely noticed incidentally.

The characteristic feature of *drosera rotundifolia* is the abundance of gland-bearing filaments—tentacles, Mr. Darwin calls them, from their manner of acting—which cover the upper surface of its round leaves. There are on the average about two hundred of these tentacles to each leaf; and as their terminal glands are always surrounded by drops of extremely viscid secretion, which glitter in the sun like dew-drops, the plant gets from them its poetical common name. It gets more—and that is its living; for its short and simple roots are capable only of absorbing water. It is by means of the secretion of the glands and the inward bending of the tentacles that its prey are caught, digested, and absorbed. The glands are wonderfully sensitive to pressure and repeated touching; and when excited, the tentacles bend inward to the centre of the leaf and remain inflected over the captured object according to the amount of nutrition it affords.

Extremely minute particles of glass, cinders, hair, thread, etc., when placed on the glands, cause the tentacles to bend; but the inflection is not so energetic nor so persistent as when the exciting substance is organic and soluble. So sensitive are the glands that a bit of human hair, exerting a pressure of not more than a millionth of a grain, suffices to induce a movement of the tentacles. The pressure of the delicate feet of gnats causes them to be quickly and securely embraced. The tentacles are indifferent, however, to single touches and even hard blows, also to the repeated blows of drops of rain; greatly to the plant's advantage, Mr. Darwin remarks, for it is thus saved from much useless movement. The absorption of animal matter and various fluids, heat, and galvanic action, also cause the tentacles to become inflated, the movement beginning in about ten seconds when a bit of raw meat is applied to a gland.

The bending of the tentacles is effected by a process of aggregation of the protoplasmic contents of the glands and tentacles. This aggregation is excited by all the stimulants which produce movement: the quickest and most energetic of the many stimulants tried being carbonate of ammonia, a dose $\frac{1}{134400}$ of a grain sufficing. The process of aggregation goes on only as long as the protoplasm is in a living, vigorous, and oxygenated condition. Immersion in warm water causes the leaves to be inflected and increases their sensitiveness to the action of meat, Inflection is rapid at temperature between 115° and 125° Fahr. Temporary paralysis ensues on exposure to 130°, but the leaves recover on being left for a time in cold water. Exposure to 150° causes death: so does prolonged exposure to 145°. Different leaves, however, and even separate cells in the same tentacle, differ considerably in their power of resisting heat.

By testing the leaves with various nitrogenous and non-nitrogenous fluids, Mr. Darwin found them able to detect with almost unerring certainty the presence of nitrogen. Results so obtained led to the inquiry whether the plant possessed the power of dissolving solid animal matter, that is, whether it really had the power of digestion like that possessed by animals. Numerous experiments proved conclusively that the leaves of drosera are capable of true digestion, and that the glands absorb the digested matter: the most interesting, Mr. Darwin thinks, of all his observations on this remarkable plant, as no such power had previously been known to exist in the vegetable kingdom. The resemblance of drosera digestion to that of animals is singularly close. The digestive secretion is more copious in the presence of nutritive material, and is distinctly acid, like that of the animal stomach. It also contains a ferment closely analogous to or identical with the pepsin of animals, which is secreted only when the glands are excited by the absorption of already soluble animal matter. Albumen (hard-boiled egg), roast meat, fibrin, areolar tissue, cartilage, fibro-cartilage, bone, milk, casein, legumin, and other substances were found to be acted on by the plant secretion precisely as by the gastric juice of animals. Fresh gluten was too strong for the plants; but after the starch was removed by treatment with weak hydrochloric acid, it was digested rapidly. Starch is indigestible, and so are epidermic substances, such as human nails, hair, quills of feathers, fibro-elastic tissue, mucine, pepsin, urea, chitine, chlorophyll, cellulose, gun-cotton, fat, and oil: all of which are similarly unaffected by gastric juice, though some of them are acted on by other secretions of the animal alimentary canal. The plants are also, to a limited extent, vegetable feeders, having power to digest some parts of leaves, and to partially dissolve pollen and living seed. Like animals, too, these plants suffer grievously from dyspepsia, in case of surfeit, even of the most digestible substances.

The sensitiveness of the leaves to carbonate of ammonia has already been mentioned. Like effect, in varying degree, is produced by all the other salts of ammonia. The citrate is least, and the phosphate most, powerful. Of the latter, less than one twenty-millionth of a grain in solution, applied to a gland, is sufficient to cause the tentacles bearing the gland to bend to the centre of the leaf. Many other salts were experimented with, the nature of the base proving, as in the case of animals, far more influential than that of the acid. Nine salts of sodium all caused well-marked inflection, and none were poisonous in small doses; whereas seven of the nine corresponding salts of potassium produced no effect, two causing slight inflection. Some of the potassium salts were poisonous. The so-called earthy salts produced little effect; on the other hand, most of the metallic salts caused rapid and strong inflections, and were highly poisonous. To this rule there were some odd exceptions; for example, the chlorides of lead and zinc and two salts of barium did not cause inflection, and were not poisonous. Twenty-four acids were tried, much diluted: nineteen caused the tentacles to be more or less affected. Most of the acids were poisonous. Benzoic acid is very poisonous, though innocuous to animals. Many of the poisonous acids caused the secretion of an extraordinary amount of mucus, long ropes of it hanging from the leaves when they were lifted out of the solutions. Allied acids act very differently, formic acid, for instance, producing but slight effect, while acetic acid of the same strength is poisonous and acts powerfully.

A large number of vegetable alkaloids and other substances were experimented with, developing some very curious results. Substances like strychnine, nicotine, digitaline, and hydrocyanic acid, which act poisonously on the nervous system of animals, are also poisonous to drosera, but probably excite inflection by acting on elements in no way analogous to the nerve-cells of animals. The poison of the cobra, so deadly to animals by paralyzing their nerve-centres, is harmless to these plants, though causing quick and strong inflection. The absence of nerve elements is made still more probable by the indifference of the plant to morphia, hyoscyamus, atropine, veratrine, dilute alcohol, and other substances which produce a marked effect upon the nervous systems of animals.

To summarize the physiology, so to speak, of the plant's sensitiveness, and the manner of its manifestation, would expand this article beyond limits. The structure and movements of six other species of drosera have been studied, though less extensively than those of the common sundew. They are all insect-catchers, using very nearly the same means.

More wonderful in its adaptation to a carnivorous life is the Venus flytrap, found only in the eastern part of North-Carolina. Its poorly developed roots, like those of drosera, are capable only of absorbing water, so that, lacking its predaceous habit, it would soon cease to exist. Its manner of catching insects and general behavior have already been described in this paper in the observations of Mrs. Treat. Like the sundew, it is extremely sensitive to the touch of edible matter, yet indifferent to rain-drops and gusts of wind. This is the more remarkable in the case of the Venus flytrap, since it captures its prey, not by means of a viscid secretion, but by a sudden shutting of its leaves, trap-fashion. The digestive power of this plant varies somewhat from that of drosera. The secretion from its glands dissolves albumen, gelatine, and meat, if too large pieces are not given. Fat and fibro-elastic tissure are not digested, nor is chemically prepared casein or ordinary cheese. The mechanism of the dionœa trap is such that minute insects escape, while the relatively large ones are retained: an arrangement which Mr. Darwin regards as very beneficial to the plant, inasmuch as it would manifestly be a great disadvantage to the plant to waste many days in remaining clasped over a minute insect, and several additional days or weeks in afterward recovering its sensibility. The amount of nutriment would not compensate for the effort. There is evidently room, however, for further investigation in this direction, since, owing to the limited digestive power of the leaves, a single large insect is often too much for them. As in the drosera, the impulse which causes motion in the leaf travels in all directions through the cellular tissue, independently of the course of the vessels of the leaf. It was in this connection that Dr. Burden-Sanderson made his wonderful discovery that there exists a normal electric current in the blade and foot-stalk of these leaves, and that, when the leaves are irritated, the current is disturbed in the same manner as during the contraction of the muscle of an animal.

The characteristics of the less known insectivorous plants will be summarized in another article.

THE CHINESE OIL-TREE.

BY M. S. CLOËZ.—*Elæococca vernicia*, the oil-tree of China and Cochin China, is a plant of the family of the *euphorbiaceæ*. Its seeds, when submitted to strong pressure in the cold, yield about 35 per cent of a liquid oil, colorless, inodorous, and almost insipid. Its specific gravity, at 59° Fahr., is 0.9362. At —32° it thickens, without losing its transparency or crystallizing. By treatment with ether, 41 per cent of oil can be extracted from the seed, slightly colored, but presenting otherwise all the character of the oil obtained by pressure. If, instead of ether, purified bisulphide of carbon is employed, the fatty matter remaining after the solvent has been evaporated off at 212° solidifies on cooling, forming a number of small reniform masses, which present under the lens a decided crystalline texture. This solidified fat has the same elementary composition as the liquid oil obtained by pressure, and melts at 93°.

The oil extracted by pressure in the cold is rapidly solidified by light in the absence of air, an effect which, on further experiment, was found due to the more refrangible rays of the spectrum alone. The oil of *elæococca* is the most drying of all oils. If spread on a plate of glass or metal, it dries in a few hours, on exposure to the air.

INSECT FERTILIZATION OF PLANTS.

PROFESSOR MEEHAN disputes several assumptions relative to the above. He concludes that the great bulk of colored flowering plants are self-fertilizers; that only to a limited extent do insects aid fertilization; that self-fertilizers are every way as healthy and vigorous, and are immensely more productive than those dependent on insect aid, and that, when plants are so dependent, they are the most fitted to engage in the struggle for life.

THE ARTIFICIAL COLORING OF PLANTS.

A SIMPLE and well-known chemical experiment, showing the action of sulphurous acid on vegetable coloring matter, consists in placing in that gas violets, which become almost instantly bleached. Sulphurous acid, by its deoxidizing properties, destroys the color of a large number of other flowers, such as roses, periwinkles, etc., and its effects may easily be noted by the little apparatus shown in Fig. 1. This consists of a capsule in which sulphur is ignited to generate the acid, covered by a conical metal chimney, at the orifice of which the flowers to be bleached are placed.

Quite recently M. Filhol has exhibited, before the members of the French Scientific Association, new results, ob-

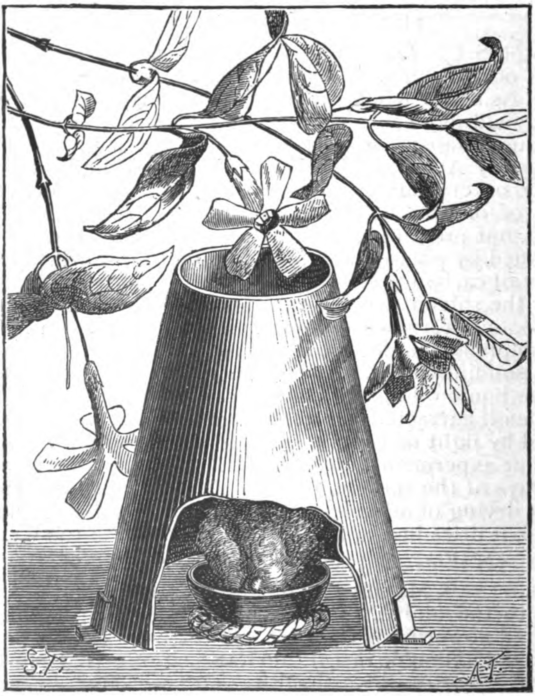

FIG. 1.—DISCOLORATION OF FLOWER-PETALS BY SULPHUROUS ACID.

tained through the action of a mixture of sulphuric ether and a few drops of ammonia upon flowers, from which it seems that a large number of the latter, normally of a violet or pink color, become, when immersed in the mixture, an intense green. The editor of *La Nature*, from which journal we extract the engravings herewith given, has continued the investigations of M. Filhol, and deduces an interesting series of experiments, the description of which we present below.

Into a wine-glass, Fig. 2, pour a quantity of ordinary ether, and add about one tenth its volume of liquid ammonia. Into this the flowers are to be plunged. The purple and pink tinted flowers, which become bright green, ap-

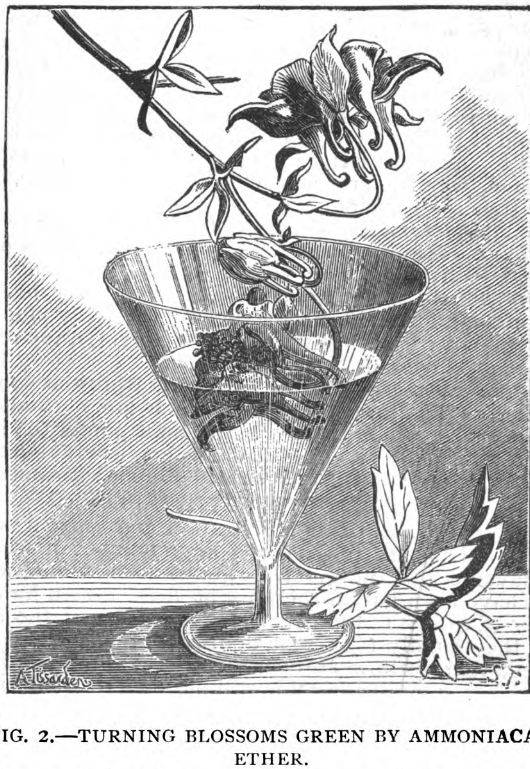

FIG. 2.—TURNING BLOSSOMS GREEN BY AMMONIACAL ETHER.

pearing as if dyed by a copper salt, are the red geranium, the violet periwinkle, lilacs, roses (red and pink), gillyflowers, thyme blossoms, blue-bells, heliotropes, and myosotis. Other flowers of different shaded colors acquire different tints. The upper petal of the violet sweet-pea becomes a dark blue, while the lower petal turns to a light green. Sweet-william changes to brown and light green. White flowers usually become yellow, this being the case with the white poppy, the snapdragon, which turns yellow and dark violet, the white rose, which changes to a straw tint, the white columbine, the chamomile, the syringa, the white daisy, and the white rocket, the honeysuckle, the bean, the white potato-blossoms, the meadowsweet, and the white foxglove. In the pink sweet-pea, the upper petal becomes blue, and the lower one a soft green. The pink geranium turns blue in a remarkable manner. The red snapdragon becomes of a fine metallic brown, the valerian of a grayish color, and the red wild-poppy of a fine violet. Yellow flowers in the ammoniacal ether remain unaltered. Red turns green in a very curious way when put in the mixture. The action of the chemical is so rapid that the merest sprinkling of it on the leaf is sufficient to cover the latter instantly with green spots. In the same way flowers may be spotted with white, even while they are growing.

The most interesting changes of color are those which take place in flowers which are variegated. Thus particolored fuchsias become yellow, green, and blue. All flowers which have taken a new hue may be kept from changing back again for several hours by plunging them in pure water. Eventually, however, they regain their natural colors.

Another curious fact to be noted in the present connection is that the flowers of asters, which are naturally inodorous, acquire an agreeable perfume under the influence of the ammonia. The same flowers, when violet, become red when wet with nitric acid diluted with water.

PERMANENCE OF VITAL POWER.

IN clearing away the refuse from the ancient silver mines of Laurium, in Greece, a large number of seeds of a papaveracea of the *glaucium* genus were found, which must have been buried there for at least fifteen hundred years. Exposed to the beneficent influence of the sun's rays, they rapidly took root, flourished, budded, and blossomed, their yellow corollas being beautiful in the extreme. This interesting flower, unknown to modern science, is particularly and frequently described in the writings of Pliny and Dioscorides, and is thus again resuscitated, after having disappeared from the surface of the globe for more than fifteen centuries.