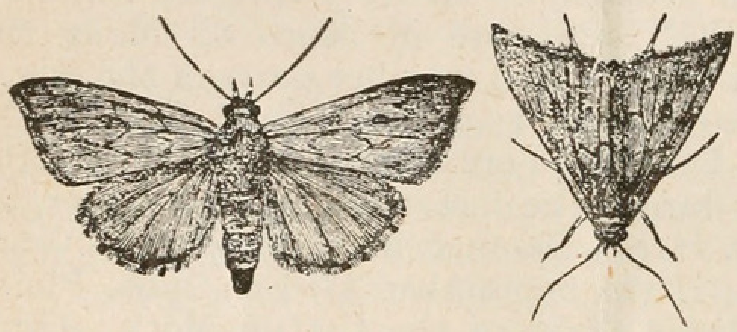
swarms appeared at Hamilton on October 7th. In the year 1903, on October 5th and 8th, the late Dr. Fletcher and the writer when "sugaring" for noctuid moths, at the Central Experimental Farm, collected many specimens of this moth which had been attracted to the trees upon which the "bait" had been applied.

The fact that these moths migrate to Ontario in autumn from the Southern States is most interesting. The remarkable thing too, is that large numbers of the specimens are in such perfect condition, that one wonders how the moths make such long flights without in some way damaging themselves. Their wings, however, are very closely-scaled, so can withstand considerable knocking about.



THE COTTON MOTH, (AFTER RILEY).

The figure herewith shows the Cotton Moth, with the wings spread, and also illustrates its habit of resting with its head downward. In colour it is brownish-yellow with a purplish sheen. On the front wings are indistinct wavy transverse lines and near the centre of each a conspicuous dark spot, paler in the middle.

The caterpillars of this moth have caused enormous losses in the cotton fields of the south. Before the year 1873, annual losses from the ravages of the Cotton Worm amounted to millions of dollars, in fact in certain years of general prevalence of the worm, the loss totalled as high as $30,000,000. Since the above year, however, the insect has been kept largely under control by a change in cultural methods and the use of Paris green and other arsenical poisons. The caterpillars are, therefore, not now, nor have they been for some years, a serious factor in cotton growing.

THE NATURE OF PARASITIC FUNGI AND THEIR INFLUENCE UPON THE HOST PLANT.

BY H. T. GUSSOW, DOMINION BOTANIST, OTTAWA.

By far the largest number of fungi causing plant diseases are of microscopic character, hence I will confine my remarks exclusively to this large enough group. The average fruitgrower's and the average farmer's acquaintance with microscopic fungi, is, I believe I am correct in stating, one of practical knowledge rather than of scientific conception. This knowledge again is mainly based on personal observations of such common forms as moulds, which are met with in all places and of probably some of the more prominent symptoms noticeable on vegetation, resulting from the attacks of parasitic fungi, than by the actual study of these forms. Of these latter the rust and smut fungi, no doubt, are the best known forms.

Many of the microscopic forms of fungi which we may find on dead plants and parts of plants, have appeared considerably like moulds on clothing, wallpaper, bread, etc.—i.e., they have not been responsible for the death of the plant. These fungi have been designated as saprophytes and are by their mode of life distinguished from parasitic fungi which are capable not only of attacking living plant tissues, but also of maintaining themselves from the food manufactured by the attacked plant for its own use, which partnership frequently results in serious injury or death of the host plant.

Microscopic fungi as the name indicates are extremely minute organisms whose study necessitates a more or less powerful microscope. Indeed, we will find that notwithstanding the minuteness of these objects, some are of a decidedly complicated structure. The use of a microscope will readily reveal a vegetative and a generative portion in each of these individuals.

The vegetative part of fungi is analogous in a certain degree to the roots, stem, branches and leaves of higher organized plants inasmuch at any rate as the vegetative parts of a fungus are responsible for the taking up of food required for its own use. The vegetative portions of fungi consist of very fine, branched, more or less long, transparent or coloured tubes, which may be likened to a human hair or fine capillary glass tubes. These tubes are technically known as vegetative hyphae. They are exceedingly small, measuring often less than a two-thousandth part of an inch in breadth, while their length may vary from a twenty-fifth of an inch to large dense masses covering whole parts of plants. The contents of these tubes consist of protoplasm which is in many cases partitioned off by means of small separating walls or septa. The hyphae may develop within the tissues of plants or cover their surface; collectively they are spoken of as the mycelium.

As soon as the vegetative part of a fungus has had time to undergo a certain development or growth, the generative portion is produced. This consists of the reproductive organs or fructification which may be of very diverse construction, but which like the seeds in flowering plants, serves the purpose of reproducing its kind. Reproduction of fungi is effected by spores which when ripe leave the parent plant in various ways and which are capable of growing independently into new plants. The sexual development of fungus spores, similarly to the seeds of higher plants is accurately known in a few instances. It is generally accepted that most fungus spores are produced asexually, that is without egg and sperm cells. The simplest form of spore production is that of the conidiospores. It takes place by the rising up from the mycelium of a number of erect hyphae, all of which produce at their tips a single or a series of spores. These spore-bearing branches are known as conidiophores. Frequently these conidiophores branch and each branch segments itself into successive spores. This is the case for instance in the fungus causing the common potato disease *Phytophthora infestans*. In other fungi the production of spores does not take place by this act of segmentation, but the contents of the hyphae itself generally form into spherical spores. In this way the smut spores of grain are produced.

A very common method of spore production is that in which the spores are produced in separate tubes, small sac-like organs, technically termed asci. These are much broader than the hyphae and are generally club-shaped. Each ascus contains from two to eight spores often more, but always an even number. The spores produced in this manner are known as ascospores and the whole group endowed with this method of reproduction is known as ascomycetes. These forms of fungi are again subdivided according to the number of spores in each ascus and by the manner the asci are produced, which may be singly as in the Peach Leaf-curl fungus, or in flat or rounded discs as in peziza or in fruiting bodies similar to pycnidia , but here termed perithecia. These conditions of spore production may become still more complicated, as even one species may produce several kinds and crops of spores.

The spores of microscopic fungi differ greatly in size and form. Their colour is more generally hyaline or transparent, but they may also be brown, grey, pink, etc. Their form varies greatly: they may be oval, round, rod-shaped, or sickle-shaped, with pointed or rounded ends. They may be of single cells, or divided into two or many sections, smooth or pitted, with netlike markings or appendages. Thus they will be found to be very different objects, but their appearance is constant in each fungus. These characters, together with the manner in which they are produced are regarded as specific and generic distinctions and are largely used for the purpose of classification. When ripe the spores are shed in various ways, the conidiospores simply become detached and are carried by the air.

Spores produced in pycnidia or perithecia may either ooze out, or be expelled with force through a hole at the apex of the fruiting bodies. Others again are freed by the collapse or decay of the conceptacles in which they are produced. When ripe the spores either pass through a period of rest, as winter spores, or they immediately germinate, when they may be regarded as summer spores. Germination can only be accomplished successfully when there is sufficient moisture available. Hence we all have had the experience of seeing some fungus disease spreading rapidly during moist warm weather (Apple and Pear Scab, Potato Disease, Mildews, and others). Under favourable conditions the spores take up a large quantity of water and begin to swell, often to double their original size. The next step in germination is a rupture in a cell wall and the protruding of a germinal hypha, which is pushed into the particular substratum (leaf, twig, etc.), where it quickly begins to ramify. We have considered previously the great variation of the fungus spores. The germination of the various spores is likewise very different and frequently an important factor for distinction of species. Conidiospores most generally germinate by producing directly one or more germinal tubes which are capable of infecting plant tissues. Smut spores, however, produce first a so-called short promycelium on which secondary and even tertiary spores may be formed which on germination produce the tube causing infection. The loose smuts of barley and wheat, however, produce infection tubes directly. Similar in behaviour are the teleutospores of our rust fungi. They also produce a promycelium and secondary spores when germinating.

Still more different is the germination of the spores of the common potato fungus. Here the contents of the conidia produced by segmentation of the branches breaks up into minute microscopic bodies, which for some time may be seen rapidly swarming about. After a very short period, however, these swarm spores become stationary and their walls thicken until they finally germinate by producing the typical infection tube.

There are numerous fungi which produce both summer and winter spores. The Black Knot of plums and cherries, the Powdery Mildew of grapes, Scab of pears and apples all produce two forms of spores. The ascospores are nearly always winter spores. The teleutospores of rusts, or egg spores of the Peronosporae, which cause the downy mildews are not ascospores, though typical winter spores. The summer spores serve the purpose of a rapid propagation of the fungus, while the winter spores are responsible for carrying diseases over the winter. Very rarely may summer spores be carried through the winter alive, owing to their feeble protection and short life. The winter spores are produced in conceptacles, which are exceedingly well protected. They adhere firmly to the substratum on which they have been produced or are imbedded therein.

Our next problem to consider is the mode of life of fungi and their influence upon the host plant.

Green plants or chlorophyll-bearing plants manufacture their food, as you know, from the carbonic acid of the air by means of the small chlorophyll grains in their leaves and by the action of sun and water. This physiological process is known as "assimilation." The first visible product of assimilation is starch. The starch again undergoes certain changes and forms carbohydrates like dextrose and sugar, which are used as food by the plants. In other words, the manufacture of food necessary for the growth of the green plants takes place in the chlorophyll-bearing portions by means of this chlorophyll substance. Fungi possess no chlorophyll. Hence, they are not able to utilize directly the carbonic acid of the air. They are compelled to search elsewhere for the carbohydrates essential for their development and accomplish this by living upon substrata from which they are able to obtain a "ready-made" supply of food. Parasitic fungi live upon plants in various ways. They may be confined to the surface entirely like the mildew fungi, when there will be produced on the mycelium peculiar sucker-like organs—so-called haustoria—by which they absorb their food from underlying cells. Other fungi, by far the greatest number, live within the tissues of the host plant. They may also produce haustoria, but more generally the absorption of food takes place directly by the action of the vegetative hyphae on the infected tissues.

Following the growth and development of parasitic fungi, a collapse of these cells, robbed of their contents, takes place and the earliest symptoms of disease appear. Often the infection is exceedingly local and the result is the production of smaller or larger spots of dead tissue. The shot hole fungi of plums, cherries and peaches, illustrate well this peculiarly confined growth. Quite recently my attention was called to the outbreak of an alarming disease among cherries in Prince Edward Island. On investigating the epidemic I found that this trouble was due to a common plum and cherry leaf spot fungus which had defoliated practically all attacked trees. Two or three years' repetition of this malady has resulted in the wholesale destruction of cherries in this Province.

Other fungi may attack, besides the leaves and fruit, the young shoots of trees and destroy last year's growth and thus much of the expected harvest. Others again, cause cankers which spread from year to year until the whole branch is ringed and shut off from the food supply. Formations like the enlarged portions of plants, which occur in black knot, plum pocket, club root, etc., are also very common.

It now becomes necessary to briefly consider the question of the predisposition of plants towards disease. The word predisposition may not be fortunately chosen to describe the peculiar observations that may be made in the direction of resistance or susceptibility towards disease. In medicine as well as in plant pathology we often meet with typical cases of immunity in animals or plants. For some reason or other some individuals escape a disease altogether, or remain singularly resistant in recovering unhurt from an attack. Hence, modern investigators claim that the successful selecting of resistant varieties would sooner or later decide the question of treatment for disease. This expectation is undoubtedly quite reasonable, but at present we have only just begun to open our eyes and the results obtained so far have more of a scientific than a practical value. Disease resistance has been established to a certain degree in grain—considering the rust problem, but unfortunately the varieties fairly rust-proof showed other undesirable characters, or they were disease-proof only in a small locality. We must also bear in mind that the adaptation of disease-causing organisms to new conditions will play a very important role, and at present while there is every hope of improving our knowledge in this respect, our results are not established long enough to speak the last word in the breeding of disease-resistant varieties. It would, however, be quite erroneous to construe my remarks in a manner in which they were not intended. While pointing out the difficulties, yet there is every hope of making important discoveries along these lines.

Next, let us consider the resistance to disease. In medicine we are informed that living according to common, normal sense, avoiding foods or practices which lead to the weakening of the organism, we will not only reach but maintain a condition which we describe simply as health. Health, to my mind is nothing else but the keeping of body and mind sound by performing the normal functions of our organs. Thus, by following closely our needs and by living correctly we can bring our bodies into a state of great resistance and even immunity, though we may be living amidst a serious epidemic at the moment. Infectious germs, though surrounding us constantly, will have no chance of exercising their serious effect upon us if we are in a perfectly sound state of body. It is quite impossible to avoid contact with disease germs and this being the case, prevention of disease is largely dependent upon success in bringing our organism into a strong condition of resistance. This, of course, is exactly the same in plants. Plants are living beings subject to all kinds of ills without being actually diseased, i.e., being attacked by a specific organism bringing about a pathological condition. Prof. Marshall Ward of Cambridge, England, has expressed himself very instructively on the subject of predisposition to disease in plants. He refers to two plants of the same kind as much alike as possible in every respect, size, condition, development, etc., and goes on to say, "Picture to yourself one of these plants growing under the most perfect conditions, supplied with the proper amount of food, its roots expanding into a well-ventilated soil, rich in humus and plant food, etc., and the other growing under absolutely reverse conditions." The result will be in one case a strong healthy plant and in the other, a poor weakened plant just strong enough to keep alive. Now the conditions, not to say constitutions of these two plants must be very different. Different modes of nutrition we know produce different chemical changes within a living plant. And, no doubt, this difference in the condition of the host plant is accountable for its power of resistance or state of susceptibility. There may be a number of other factors producing similar differences in constitution or in composition, if this is more correct. A potato tuber sound and fresh, will remain free from fungi if kept in an ordinary room, while one that has been exposed to frost or steam heat for a moment will soon be covered with mould fungi of various kinds. We know of course that we have changed the chemical composition of the potato exposed to frost or heat, but we have also partly destroyed its life. The same may be said of Prof. Ward's "ill-treated" plants. Together with the changes of the chemical composition, we have reduced its vital power; hence, would it not be reasonable to expect an increased resistance to disease if the vital power of any living organism is kept up to the highest mark? That this contention is fundamentally correct is amply proven by the fact that cultivated plants which we grow under conditions to which they are not fully accustomed are, generally speaking, more subject to disease, likewise as Europeans are much more liable to disease in tropical climates and vice versa. Sudden or even gradual changes frequently result in lowering the vitality of a living organism. Cultivated trees are constantly subject to such unnatural changes.

I have endeavoured to explain briefly, in the foregoing remarks, the life and nature of parasitic fungi. We have considered how fungous diseases are spread by means of the spores produced by the causal organism, we know how different may be their modes of fructification and that winter and summer spores must be looked for in many kinds, and we have further discussed the effect of a fungus on the host plant and hinted at certain factors rendering plants more or less susceptible to disease.

From the practical standpoint of the control of disease in our crops a knowledge of these different aspects of the subject is necessary in order that the organism causing the disease may be attacked where it is most vulnerable. We see that in spite of certain general principles the methods to be adopted against different diseases will vary with the life-history of the causal organism and hence has arisen the necessity for close investigation of these life-histories and the finding of methods of treatment based upon them which together form so large a portion of the work of the Plant Pathologist.

THE ENTOMOLOGICAL SOCIETY OF ONTARIO.

The Forty-eighth Annual Meeting of the Entomological Society of Ontario was held at the Ontario Agricultural College, Guelph, on November 23rd and 24th. The reports of Directors Gibson, Grant, Cosens and Treherne on the destructive insects of the year in their respective districts showed that many of the well known pests had been present in large numbers and that consequently much damage to various kinds of crops had resulted from their attacks. Such insect pests as the Codling Moth, Apple Maggot, San Jose Scale, Plum Curculio, Oyster Shell Scale, Cutworms, Root Maggots, etc., were reported upon by the above Directors, and by Dr. C. Gordon Hewitt and Mr. L. Caesar, of the O.A.C., during the afternoon of the first day's session. An interesting account of "The Work of the Division of Entomology" of Ottawa was given by Dr. Hewitt, in which statements were made of the several branches of the work which is now carried on under his direction. During the same afternoon a paper by Rev. Dr. T. W. Fyles, of Hull, Que., on "Notes of the Season of 1911" was presented, in which observations were recorded which had been made by this veteran entomologist during the past summer.

At the evening meeting, held in Massey Hall, a happy address of welcome was presented to the members by President Creelman. Dr. William Riley, of Cornell University, who was to have delivered the Popular Lecture, unfortunately was too ill to be present, but his place was taken by Dr. Hewitt, who gave a most interesting address on "Insect Scourges of Mankind." The two dreaded diseases which are rampant in sections of Africa, viz.: Nagana, which is destructive to domestic cattle and horses, and the Sleeping Sickness, which depopulates many districts, both